THE ARTS

OF

TANNING, CURRYING,

AND

LEATHER-DRESSING.

Z. Pratt

THE ARTS

OF

TANNING, CURRYING,

AND

LEATHER-DRESSING;

THEORETICALLY AND PRACTICALLY CONSIDERED
IN ALL THEIR DETAILS.

EDITED FROM THE FRENCH OF

J. DE FONTENELLE AND F. MALEPEYRE,

WITH NUMEROUS EMENDATIONS AND ADDITIONS,

BY

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"CHEMICAL AND PHARMACEUTIC MANIPULATIONS," ETC.

ILLUSTRATED BY TWO HUNDRED WOOD ENGRAVINGS.

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PREFACE.

THE present work has been prepared to meet the growing demand for information as to the practical application of scientific principles, which characterizes the progress of the arts; and is offered to that portion of the public which is interested in the branch of manufactures of which it treats.

The first intention of the Editor was to reproduce, in translation, the French Manual of J. de Fontenelle and F. Malepeyre, but in the course of his labors its imperfections became so manifest that the original plan was abandoned for a substitute which would better realize his purpose of making a full and comprehensive treatise upon the manufacture of the different kinds of leather. To this end, such portions of the French work as were valuable and novel, were either translated or remodelled; while the information in which it was deficient, was directly supplied or derived from other sources.

For the purpose of procuring the desired information, inquiries have been directed over a wide range of the country, sometimes by letter, and frequently in person.

In this way, most accurate knowledge has been obtained; and although, often, much of the time of manufacturers and others has been exacted in giving explanations and descriptions, these have always been rendered with willingness, and with the manifest desire to co-operate for the advancement of the Art. The editor takes pleasure in acknowledging his indebtedness to those who have so kindly assisted him by contributing important facts, and desires to express his particular obligations to the Hon. Z. Pratt, Hon. J. C. G. Kennedy, Prof. J. C. Booth, Prof. L. D. Gale, and S. Sparhawk, Esq.

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ERRATA.

Page 34,	9th line from top,	*for*	"wall,"	*read*	well.
" 35,	7th line from bottom,	"	"empires,"	"	emprises.
" 162,	11th "	"	"peck,"	"	quart.

THE

ARTS OF TANNING, CURRYING,

AND

LEATHER-DRESSING.

CHAPTER I.

INTRODUCTION.

THE art of tanning is that by which animal skins are converted into *leather*, a product possessing certain characteristic properties, differing entirely from those of the raw material, and eminently adapting it to the useful purposes for which it is employed. These properties are of a physical nature, and vary with the kind of skin employed, and the modifications of the process which it undergoes. Chemically considered, however, leather proper, whatever its kind, is a definite compound of tannin and gelatine, possessing the all-desirable requisites of durability, pliability, inalterability, insolubility in water, and great power of resisting the action of chemical reagents. When mineral or earthy substances are used as the leather-making agents, the result is a compound of gelatine with the base employed, and is more or less indestructible, according to the nature of the material and the circumstances under which the combination takes place.

2

Tanning, as an empirical art, dates back to antiquity; but the methods resorted to in early times, consisted of little more than merely cleansing and drying the skins; and thus prepared, the latter were used for clothing, &c. This mode, however, was very imperfect, for the bibulous nature of the skins caused them, upon the reabsorption of moisture by exposure, to resume their original liability to putrefaction and injury. In later times, these defects were remedied by immersing the cleansed and de-haired skins in infusion of oak-bark, or solution of alum; and thus, by effecting a union between one or more constituents of the liquor and the gelatinous tissue of the skin, producing a new compound endowed with desirable properties not possessed by its original components. The principles governing this reaction, have been in more recent days, developed by the investigations of Lewis, Proust, Seguin, Deyeux, McBride, and Sir H. Davy; and it is owing to the researches of these inquirers, that the occupation of the tanner has been elevated from the condition of an empirical pursuit, to that of an art based upon recognized scientific principles.

Unfortunately, however, the efforts of theoretic investigators have not always been reciprocated by practical men; and, though many improvements in the manipulations of the art have been made by the aid of ingeniously contrived machinery, and much has been done to hasten the process, by promoting the absorption of the tanning principle by mechanical and philosophical means, any economy of time that may have been thus accomplished, is counterbalanced, in the present state of the art, by a corresponding depreciation of the quality of the leather. We base a hope for a more propitious future in this respect, upon the growing interest in applied science which characterizes the times, and already, Prof. Gale, of the

Patent Office, has commenced an examination of the tannin-yielding trees of the United States, beginning with the oaks. This course is with a view of comparing the products of the same trees growing in different latitudes, so as to show the effect of climate in modifying the secretion of tannin by the organism of the growing plant—a work which will prove as serviceable to the tanning interest, as it is creditable to the disinterestedness and professional skill of its author.

Leather was largely in use among the ancient Egyptians, and the workers of that material were so numerous that the Memnonian quarter of Thebes was characterized as their especial locality. Their skill in fashioning it was so great, that ornaments of all shapes and devices were made from it. As far back as 900 years before Christ, leather was made by them into tapestry; and many of the Egyptian tombs bear representations of artificers in leather engaged in the several branches of their vocation.

The principal steps in the manufacture of leather are

1. The *Washing and Soaking*, for the purpose of cleansing and softening the skins, and preparing them for—

2. *The Depilation or Removal of the Hair.*—This is effected by the use of lime or other substances which destroy, dissolve, or soften the bulbous roots of the hairs, and thus facilitate their removal by mere mechanical scraping with a blunt-edged knife. During this part of the process, another important end is generally accomplished, in the swelling of the tissues, and their preparation for the more complete and easy absorption of the tanning principle. The primitive mode of removing the hair, was that of shaving it off with a knife, but the use of lime was known even among the early Egyptians,

When the rationale of the depilation is better understood by practical tanners, the slow and inconvenient process of depilation by means of lime, will probably give place to more effective, rapid, and economical methods, such as the use of the hydrosulphuret of calcium.

3. *Tanning.*—This step consists in promoting the combination of the gelatinous tissue with tannin, by immersing the softened and unhaired skins in an infusion of oak-bark, or other substances containing tannin. The tanning influence is probably not exerted solely by the tannin, but also partly by the extractive matter, more or less of which always exists in tanning material. During the soaking, the epidermis of the skin disappears, and the tissue of the latter is gelatinized, and thus predisposed to chemical union with the tannin. This gelatinization of the tissue is all-essential, and is promoted doubtless by the gallic acid fermentation of the tanning material. This is the more probable, since the same effect may be produced by the use of very dilute acetic and sulphuric acids, and since gallic acid has no primary or direct influence on the tanning. Time, exposure to moisture, to air, and a temperature of 77° to 86°, F., are the requisites for this fermentation, which is developed by the action upon tannin of a ferment which is always present in tanning material, converting it into gallic acid. In consequence of this change, the prolonged exposure of the liquor diminishes its tanning power.

4. Drying, rolling, and other operations intended to perfect the quality and appearance of the leather.

Leather is employed for many useful and ornamental purposes, and numerous are its applications to various branches of industry. Besides its extensive use for coverings for the head and foot, wearing apparel, sad-

dles, harness, carriages, and the purposes of the bookbinder, it is largely employed for the embellishment of objects of taste and ornament.

Independently of the direct importance of the leather trade, it exerts a very decided incidental influence in developing the resources of a country, by giving value to certain materials used in, and resulting from the manufacture. Besides the immense quantity of bark which it consumes, it furnishes the raw material which gives employment to thousands of artisans, and it has built up colonies and towns which owe their origin and progress entirely to the interests connected with it. Even the waste materials of slaughter-houses, tanneries, curriers'-shops, and workers in leather, have important applications; the horns serving for the manufacture of combs, buttons, and umbrella furniture, the hair for plasterers' use, the spent lime for the farmer, the skin-clippings for the glue-boiler, and the leather-shavings for the manufacturer of the prussiate of potash.

The following statements will suffice to give an idea of the vast extent and rapid increase of the trade in leather.

In France, a country eminent for the quantity and quality of the leather which it produces, the average number of skins annually converted into leather is

Of Oxen and Cows	857,000
" Calves	2,032,000
" Horses	111,000

amounting to 3,000,000 of *whole* skins, exclusive of sheep and calf skins; and equal in money value there, to the very large sum of $7,171,630.

In the United States, the manufacture of leather, only

beginning to be of much importance, in the early part of the present century, has been rapidly extended, until it has become—with its allied and dependent arts—one of the most prominent elements of national prosperity. Conducted originally in the most simple and primitive manner, the expenditure both of time and labor is now materially reduced by new processes and modes of treatment, which owe their beginning to various improvements which commenced in the year 1803 in Massachusetts. These improvements were the substitution of water-power for manual labor in many of the most laborious parts of the manufacture, such as the softening and cleansing of the hides before tanning, the grinding of the bark, the pumping of the tan-liquor from one vat to another, and the rolling and smoothing of the leather. After these advancements in the progress of the art, followed the diminution of the quantity of lime used for depilation, the application of heat to bark in leaches, the more frequent use of decoction of bark as the tanning agent, the introduction of steam-power, and the employment of various machines for splitting, shaving, graining, and finishing leather. In 1829, 36,360 sides of sole leather were tanned in one establishment, in the town of Hunter, Greene County, New York. They weighed 637,413 pounds, and were manufactured with the labor of forty-nine hands, and with 3200 cords of bark. A reference to Chapter XXIII., containing an account of the Prattsville tannery, will give to the reader an idea of the expenditure of labor and capital, and the results obtained by them, in a modern American tanning establishment.

In New York, which is the great commercial mart for leather from every source of manufacture, the number

of *sides* of sole leather inspected during the last five years, was as follows:—

1847	1,168,332
1848	1,325,126
1849	1,750,231
1850	2,098,740
1851	2,185,553

For the same years, the value of raw hides and skins, and of manufactured leather *imported* into the United States, was, in

	Raw Hides and Skins.	Manufactures of Leather.
1847 (ending 31st June)	$1,529,948	$135,217
1848 " " "	4,262,069	208,993
1849 " " "	3,507,300	210,143
1850 " " "	4,799,031	362,409
1851 " " "	5,964,838	411,795

We append a statistical table, compiled from the returns of the seventh census, and showing the present condition of the tanning interest in the United States:—

States.	Number of Establishments	Capital Invested.	Value of Raw Material.	Hands Employed.		Monthly Wages.		Value of Product.
				Male.	Female.	Male.	Female.	
Maine	218	732,747	892,848	787	8	17,229	28	1,620,636
New Hampshire	163	441,975	543,779	502	...	11,787	...	900,421
Vermont	152	846,250	857,946	897	...	8,907	...	587,466
Massachusetts	246	1,877,725	2,811,178	1,510	32	41,245	368	3,519,123
Rhode Island	10	42,900	40,615	88	...	829	...	75,040
Connecticut	115	360,500	458,854	407	...	10,027	...	731,000
New York	942	5,026,148	6,065,221	4,914	81	108,171	293	9,804,000
New Jersey	133	572,857	428,587	405	...	8,946	...	724,466
Pennsylvania	1,089	8,540,318	8,169,309	2,978	2	54,784	17	5,275,492
Delaware	16	99,350	99,620	108	...	2,533	...	163,742
Maryland	116	628,900	725,612	479	...	8,034	...	1,108,189
Virginia	341	676,983	498,926	900	6	18,643	62	894,877
North Carolina	151	251,055	191,287	872	1	5,291	4	352,585
South Carolina	91	184,835	181,679	264	...	8,667	...	261,882
Georgia	140	262,865	185,604	402	...	7,107	...	261,586
Florida	4	9,400	4,800	12	...	189	...	9,200
Alabama	149	200,570	158,247	457	6	7,700	45	335,911
Mississippi	92	145,615	111,474	266	3	4,924	25	229,407
Louisiana	15	38,800	26,440	51	3	980	22	56,025
Texas	22	38,850	18,624	63	1	1,007	10	52,050
Arkansas	51	42,100	35,230	110	...	1,814	...	78,774
Tennessee	394	490,820	396,159	916	6	14,838	32	746,484
Kentucky	275	768,455	537,147	877	2	14,417	9	985,267
Ohio	706	1,840,389	1,118,080	1,826	...	35,830	...	1,964,591
Michigan	60	236,000	203,450	265	...	6,782	...	368,980
Indiana	358	514,897	405,838	886	2	15,109	14	714,813
Illinois	96	188,378	129,907	240	...	5,145	...	244,028
Missouri	148	228,095	247,956	412	5	8,306	41	466,241
Iowa	14	20,350	10,745	28	...	548	...	24,520
Wisconsin	8	78,050	93,380	75	...	1,710	...	176,710
New Mexico	1	500	200	3	...	60	...	940
Dist. of Columbia	2	25,000	25,600	10	...	270	...	40,000
Total.	6,263	18,900,557	19,613,237	20,909	102	416,214	970	32,861,796

About 6,000,000 skins of sheep, goats, and other small animals, are tanned and dressed annually, which are not included in the above table.

CHAPTER II.

THE DIGNITY OF LABOR WHEN ASSOCIATED WITH INTELLIGENCE; WITH A REFERENCE TO THE CAREER OF ZADOCK PRATT, THE TANNER.

No one of the numerous phases of modern extravagance is more fraught with danger to the institutions of society, and the general welfare of its members, than the increasing and indefinite desire for changes in the established relations of intelligence, labor, and capital, and the attempts to arrive at an Utopian state of existence, in which all men shall be producers and consumers in a certain fixed ratio, irrespective of their original or acquired advantages of ability and fortune.

The production of the greatest good to the greatest number, should certainly be an axiom of public policy, as well as a philanthropic hope; but it is not to be accomplished by either theorists or moralists. It must depend for its fulfilment upon the combination of the results of individual toil and intelligence, sanctified by contentment and devotion to the duties of our being, and preserved by a recognition of those fixed laws which have made men unequal both in mental aptitude and physical circumstances.

If man were the creator of a system for his own pursuits, he would find it necessary to constitute diversities, so that the inequalities would produce emulation, laud-

able ambition, enterprise, and the numberless qualities which make up the sum total of the good purposes of life.

If all men were made alike rich or alike poor, only a momentary state of circumstances would be produced, a starting-point, from which, at the very first step, each one would begin to diverge according to his capacity; and there would never again be such a condition as that at the beginning.

Those who attempt to bring society together by artificial means, such as socialism, and expect to hold it in compact by the influences of mere dogmas or doctrines of creed, are visionary reasoners, who, in contemplating the desired change in the mirrors of their own fancies, would starve by their ideal creations, if it were not for the industry of those who deal in tried realities.

There are two great levers which sustain us: the one is employment; the other, the knowledge of how to regulate and improve it. In other words, they are the union of occupation and instruction. Nothing can give more satisfaction to the mind than the enjoyment of the necessaries and comforts of life, flowing from the industry of him who earns them. This is the fruit of occupation; and the improvements of society follow in proportion as the occupied mind advances in proper cultivation.

The vain idea that labor is inconsistent with learning or respectability is one of the attributes of weak minds, ignorant of the nature of the ligaments which bind society together. It is one of the follies of antiquated fashion, which is passing away; and we are now beginning to consider the mechanic trades, and all branches of honest industry, as the co-ordinate and necessary associates of education, integrity, and manliness.

It may not be inappropriate to the foregoing remarks, or foreign to the purpose of this work, to refer, in this connection, to the career of one, a large part of whose life has been spent in successful devotion to the pursuits of which we are about to treat; a career which has illustrated in a striking manner the advantages of united industry and intelligence, and one which furnishes the strongest incentives to the exercise of those qualities on the part of others.

Mr. Pratt is a native of Rensselaer County, New York; and was, at an early age, an assistant in his father's tannery. When a boy, he had the opportunity of being present at the funeral of the great Washington; an event which was calculated to consecrate his patriotism, and operate as a political sacrament of devotedness to all that might benefit his country and his race.

Sometimes the career of life is directed by unconsidered impulses and accidental events. The humble herdsman hears the mysterious voice of his destiny calling to him from the burning bush, to become the future lawgiver of Israel. The shepherd of the Alps, in pointing out the road to an inquiring churchman, begins his own path to the honors of the papal see. And so, in minor callings of life, are men directed by seeming casualties, that, when lightly seen, are considered as mere incidents upon the exterior of life, having no connection with the past or the future.

The history of the social operations of mankind, teaches us that, in all periods of time, apparently trifling events have altered the destinies of individuals as well as of nations, and have had their influence upon ages to come.

Sometimes the progress of oppression, rising through a series of ages to its climax, exhausts its own powers,

and, in the form of revolution, builds up a system of human freedom upon the ruins of tyrannic power.

Sometimes intolerance drives a few of the faithful of a narrow sect from the homes of their forefathers to the shores of a new and unexplored land, which, in time, becomes the asylum as well as the hope of the oppressed in every form.

The wrongs done by kings to their subjects are the precursors of the grants of rights in future ages. The flight of the persecuted is the first fluttering of the wing of liberty that is seen to come in after times. The little bark of the pilgrims is the compressed type of the mighty argosies that shall hereafter spread their canvas to the commerce of the world. So, too, is the industry of the single and gifted laborer, who, beginning his course under the auspices of good example, and having a heart suited to a proper fellowship with man, is placed in a category or current of association and action, which brings out a development of the faculties with which Providence has endowed him. The first steps in his career are all connected antecedents of his future. All good and all evil have their respective relationship; and there is, perhaps, metaphysically, no one act in either current which could be said to stand alone; each has its precursor and its consequent.

Every man seems to be surrounded by his appropriate atmosphere of life; and all its particles are suited to the course he is to pursue. The early steps partake of the element with which he is encompassed; and so he goes on, accomplishing the special principle which belongs to his nature, from the first germ of action to the last effort of intelligence.

Whether this natural fixedness of object and bent of pursuit entitle an individual to any personal credit for

what he may do in life, it is not necessary to determine. Sufficient is it for us to say, in recounting the actions of men, that they were good; and that a wise Providence has made use of them as instruments and examples for such a purpose.

It is a happy reflection to believe that we are acting the part of beneficial agents in the general concerns of life; and that, if we are even only like animated plants, we are of those whose exhalations are healthy and yield grateful odors.

The career of the subject of this memoir is an illustration of the influences of early beginnings. He was, while engaged in his father's tannery, learning the habit as well as value of industry. His presence at the funeral of the father of his country was an act of patriotic respect, inspired by what his young mind had learned at the fireside of his parents. Here, then, were two principles, from which all his future actions might have drawn their coloring. As the beginnings were good, so were the results; and we find those currents of excellences, enterprise and patriotism, running together parallel in his life. He became in due time an exemplary mechanic, and soon established himself in successful business. But when the country required the services of her sons for war, we find him, impelled by the impulse of patriotic duty, serving as a soldier in her defence.

After a series of enterprises in commerce and other occupations, and serving the general government in her armies, and his own particular State in her enrolments, in high military capacities, we see him returning to civil life with new emprises in his mind. In 1825, he made the beginning of what is now the flourishing town of Prattsville in New York. The site was selected on account of its advantages for water-power. Then, it was

a rude-looking place, a mere sloping hill covered with woods, at whose base were a few small tenements with their humble inmates. Since that time, it has, through his agency and its accessories, become an important and populous town, the sons and daughters of which, if they do not, as those of the happy valley of Rasselas, live only to know the soft vicissitudes of pleasure and repose, at least enjoy the diversified blessings arising from fruitful occupation, industry, and devotion.

He was, some years after, elected to Congress, and also chosen a democratic elector for President and Vice-President of the United States.

During his term of service in the national councils, he certainly manifested great zeal and most laudable intentions, applying his time and talents to the accomplishment of much that was beneficial to the country.

It is here that we may pause to consider how much is done in the association of labor with intelligence. The physical industry of man is certainly a high quality; but, vigorous as it is, it gains so much by its association with a cultivated intellect, that while the one, when alone, resembles the rough materials of handicraft, and the other the latent genius that is to fashion them, they both united represent the perfection of skill and its fruitful application to the production of human happiness.

In former days, trades were merely physical; none of the sciences, and but few branches of the fine arts entered into their action. True, there were some few exceptions dependent upon individual condition and scholarship; but generally, labor, in any calling, was strictly and exclusively mechanical. There is now, however, a progressive spirit which belongs to the times. Whether it has resulted from the institutions of this country, which, by casting off the trammels of political tyranny, and by

the abundance of our land for an easy support, have enabled men to think more freely and consistently with the objects of their creation and position, or is a part of a pervading principle which the Divine Being has permitted to spread through the world, is a problem for solution. Be this as it may; we see that there is evidently an advance in the different trades and their branches; a more intimate relationship between mind and the labors of the operator; a clearer working through the lights of reason; so that, even among the inferior callings, the lamp of science sheds its rays, even if it is only seen in flickerings from the distance at which it stands.

The position of Mr. Pratt, as a member of Congress, no doubt gave him great insight into subjects germane to his genius, as well as to those of national polity, in which he was necessarily an actor.

There is, perhaps, no pursuit in which so much general knowledge of men, of the interests which concern them, the structure of political society, and the various subjects of national relations, can be acquired, as in that of legislation.

There, in the councils of the nation, every representative who has ears and eyes of understanding, is per force of position obliged to learn; and when to the opportunities as well as necessity of learning is added the inclination, and still further the ambition for knowing, the result is great, in acquisition.

There is scarcely a subject of any general concern presented for the consideration of Congress, that does not involve great research; embracing in various ramifications a diversity of knowledge with which members must make themselves acquainted. The discussion of a new tariff brings out a knowledge of our national wants, our resources, our relative interests in the respective States

and with other countries, the character and extent of our manufactures, the special articles of consumption and trade which yield the largest amount of duties, and, finally, our national revenue.

The inquiry into grants of public lands, or the introduction of new States into the Union, gives rise to the geological examinations of soils, and eventually to the discovery of fossils, ores, and metals, which, in printed reports, become handbooks of information upon those special subjects.

The discussion of treaties makes them familiar with international laws as well as diplomatic history. Memorials in regard to private claims often bring to light important incidents connected with revolutionary and other events, and furnish materials for biography valuable to our citizens.

The inquiry as to a standard for weights and measures unfolds a wonderful amount of unexpected knowledge, not only as concerns quantities, values, and weights, but, in connection with the trade of other countries, carries us back to their early dealings, and shows us the dependence upon and affinity between the different steps for the civilization of mankind throughout the world.

Philosophy, for which man has a natural tendency, becomes a prevailing principle from such causes; and, even if a representative, when he quits this arena in which strife and knowledge are often so much in company, has strengthened his ties and prejudices of party, he, nevertheless, goes forth to the community with much and precise information upon important subjects which have engaged his especial attention, and becomes a well-instructed man in the general business of life.

Learning of any kind which has an intellectual foundation, and more particularly when associated with mo-

rality, is of a propagative character, and gives an appetite which grows by what it feeds upon; and hence we often find that men who have begun as unpretending representatives in halls of legislation, advance by the impulses of knowledge to still greater acquirements, and eventually become leaders in talent and position.

The mind of Mr. Pratt seems to have been particularly adapted to realize such a condition. He was, throughout, an active participant in congressional labors, and engaged not only in co-operating with his colleagues and co-legislators in their general duties, but was himself the pioneer and originator of many serviceable acts, institutions, and works.

In glancing through his memoirs, we are struck with the great variety of concerns in which he bore an active part; from the report, as chairman of a select committee in favor of establishing a bureau of statistics and commerce, to an inquiry into the condition of a new territory; embracing, in the numerous ramifications of labor, every subject of polity pertaining to his day.

It has been said that all men have their mental affinities; that some pass unheeded away without having left any "footprints in the sands of time," only because the period of their sojourning presented no occasions—no elective influences to draw out their energies or their talents; while the great are but the creatures of opportunity; or who, having been touched by the Ithuriel wand, have sprung out into light, brightness, and renown.

Opportunity is certainly a great ingredient in any effort, and without it, either offered or acquired, no voluntary act can well succeed. The characteristic traits of a man are also elements of his future; but still, it should add to the credit of the individual, who, cultivating an understanding of his nature and his latent

abilities, uses them to advantage in that "tide in the affairs of men, which, if taken at the flood, leads on to fortune."

He was twice elected to Congress, and coming from that body with all the advantages gained in such a school of varied studies, Mr. Pratt may be said to have become a new man. He was at first the intelligent novitiate, who, like one of the travellers in Gil Blas, merely glanced at the inscription upon the wall; but now, returning among his people, was like the other scholar, carrying with him the treasures which in his searchings he found hid beneath the ambiguous epitaph and the stones.

He applied his new intelligence in various ways; and in the art of tanning, has now competed for, and received for his products, the first medal ever awarded by the New York Institute in that branch of manufacture. He endeavors to create as well as to extend knowledge. He began his efforts with the rising generation, that its young members might spread and perpetuate the fruits of their studies. To accomplish this, he presented five thousand dollars to endow an academy in the town that bears his name.

In consequence of the great variety of useful offices which he filled for the public benefit, and without any other emolument to himself than honor, he was elected a member of several scientific and literary institutions and colleges; and a few years since he closed his tannery, with great personal success, after employing over six millions of dollars, without a single case of litigation, and without loss.

Finis coronat opus.

The end crowns the work; and so have the good results of his labors left a crown upon his name more endear-

ing to the good man than all the pomp and circumstance that power alone or wealth could purchase.

The time was, and in some degree still is, when reputation in honors was principally founded upon and esteemed for distinction in literature, the fine arts, the success of arms, the emblazonments of wealth, and the exemptions, luxuries, indulgences, and positions which they respectively gave. The rest, like the hewers of wood and drawers of water, who served at the building of Solomon's temple, were supposed to be sufficiently compensated by the daily penny paid for their labors. No mark or memorial was left upon the edifice of their works; and except in the narrow circle of their industry, none knew of their labors or their zeal. In the general operations of society, it is not to be expected that the mere ordinary components of that great whole shall be held in any special remembrance, either in the present or the future, for that would be the exercise of a weak and sickly anxiety to elevate those who have no distinctive merit, and to pull down in some degree others, so as to create a false, unnatural, and unjust equality.

But while no such expectation could be justified, and none such will ever be realized, while public opinion is regulated by either good sense or the dictates of justice, much will be, as has already been done by the agency of those very qualities, in placing honorable occupation of labor upon the true level of its merits.

The days of chivalry, founded upon the power of kings and nobles—the empires of war and victories—crusades of faith, and the necessary maintenance of the followers of such errantries, as well while they lasted as in "the cankers of a long peace," were the beginnings of the false distinctions which made idleness honorable, and left industry with only the reward of its own products.

Within the last century, man has been advancing to an equality in all his relations with his fellow-man. It is not merely a political change, but one which belongs to his whole range of association and rights.

The toleration in religion, the extension of the elective franchise, the repeal of tests of faith, the abolishment of imprisonment for debt, the utilitarian spirit of the age, requiring every one to contribute something of value to increase the general stock, have all tended to produce this equalization. Now, men are beginning to be appreciated for their actual usefulness, not for their mere artificial position, based upon either political causes or the accidents of fortune. Even the iron ties of party are becoming softened by the spirit and solvent influences of sense and improvement. Those who have heretofore tramped on in the downy paths of public honors and offices, enjoying by the permission and credulity of the people one high office after another, notwithstanding their own doctrine of rotation for all, are now looked upon as unprofitable antiquities, demagogues, creators of an oligarchy whose benefits are enjoyed only by themselves, and as a host of politicians, whose occupancy of places and profits, time after time, amounts to an exclusive and hereditary right in those who have no merit and contribute nothing to the common fund of good.

These are now becoming the subjects of scrutiny, and are likely, soon, to be swept away as drones upon society, and

> "Whistled down the wind, to prey at fortune."

So, too, with the men of patrimonial wealth or riches acquired by speculation. Society, while giving them a proper security for all their possessions, begins to diminish the respect formerly and lately paid to mere property.

The value of wealth, its uses, and the protection of it, are as much appreciated and considered as ever; and so they should always be; but there is a separation of the merits of the *man*—through his talents, his industry, the diffusion of his wealth in a general usefulness—from those which proceed solely from the ownership of that lamp of Aladdin, which builds without earning, and exhibits palaces and brightness that derive no reality from their possessor.

It takes time to accomplish any revolution which shall be of permanent benefit, and it is proper it should be so; as improvements are worked out in the progress of experience which could not be made in a leap from one condition to another.

The doctrine of a necessity for useful occupation in all men is a great element in this change. Men do not begin to think calmly or wisely in the turmoil of exciting pursuits. It is only when they are falling into their proper places in the great community, and putting their shoulders to the wheel to do something useful, that they perceive their relative positions, their obligations, and the duties which belong to them as integrants of the whole. It is, therefore, industry which is the groundwork of reform both moral and political; it is the basis of domestic virtue, comfort, and plenty, and the producer of what sustains a nation and improves its condition. When to this is added education, its followers are the supporters of man in all his conditions, wants, advances, and elegances of life, and are the safeguards of society.

These reflections rise spontaneously from the nature of the subject we are discussing, as being intimately connected with the career of one whose doings, as a useful citizen, we are considering.

Biography is said to be a branch of history, and is the

reclaiming or saving from time of what would otherwise be lost. If it be creditable to perpetuate the knowledge of the deeds of men in arms; of wars, that have desolated the earth and left misery and sighs to be felt again in after ages, by those who deprecate and sympathize while they read; how much more worthy an effort is it to record, in imperishable form, the good civic conduct of those unpretending men who have labored during their lives for the common weal; who make in every field two blades of grass grow where only one grew before; who distribute among little children the means and the books of learning, so that the future man may be saved from the evils of ignorance; who endow and perpetuate places of instruction; who build up manufactories, and lasting and increasing towns; and, by giving employment to thousands and thousands of their fellow-citizens, lay the foundations of occupation and industry—the sources of comfort, wealth, and social independence?

CHAPTER III.

OF TAN AND TANNIN.

The name of *tan* is applied to coarsely-powdered bark containing a principle which is the active agent in the tanning of hides. This component is named *tannin*, and is classed among the proximate principles of plants. As the essential agent in the process of tanning, we proceed to make known its chemical characters, varieties, and particularly, its action upon animal substances and oxy-salts.

Dr. Lewis, in examining nutgalls, was the first to observe that it contained an ingredient which gave a black precipitate with persalts of iron, and a coagulum with isinglass. Deyeux, who also examined galls, considered it a peculiar resinous matter, but gave it no name. Soon afterwards, Seguin, in his researches on the art of tanning, distinguished it from *gallic acid*, with which it is so often associated in vegetable substances. This chemist, in discovering its property of combining with animal matters, and especially with albumen and gelatine, and forming with them an unalterable insoluble compound, which is the basis of leather, found the key to the whole theory of tanning.

To tan a skin, is to saturate it with tannin in such a manner as to promote the slow combination of this principle with the gelatine, albumen, and fibrine contained in

the former, so as to form with them a new compound. This reaction, in the operation of tanning, does not proceed spontaneously, but is the result of a slow process, requiring great care and skilful manipulation.

Tannin has been the subject of investigation with many chemists, and, among others, Davy, Chevreul, Pelletier, Lagrange, Guillot, Hatchett, Tromsdorff, Friedler, Richter, and particularly Proust, to whom we are indebted for our first knowledge as to its nature, properties, and mode of preparation.

According to Wahnlenberg, it exists only in perennial plants, and almost solely in the permanent parts; for example:—

1. In the perennial roots of certain annual plants—as the septfoil and bistort, or snake-weed.

2. In the bark of the trunks and roots of nearly all perennial trees, especially in the true cortical portion, or that part next to the liber and sap-wood. Extractive predominates in the cellular integument, while the epidermis is usually destitute of both that and tannin.

3. In the trunks and sap of many trees.

4. In the leaves of perennial plants—but in small quantities.

5. In the leaves of different varieties of the oak; of the *rhus coriaria* (sumach); of the *arbutus uva ursi* (bear-berry); of the *arbutus unedo* (strawberry-tree), &c., in large proportion.

6. In the capsule of unripe fruit of the *quercus robur*, *ægilops* (velonia oak); *juglans regia* (walnut); *æsculus hippocastanum* (horse-chestnut), and *terminalia chebula*.

7. In the pulp of the fruit of the *punica granatum* (pomegranate); *rosa pimpinellifolia*; *garcinia mongostana* (mangosteen); and in the different species of *anona*.

Tannin has also been found in numerous other plants,

of which special mention will hereafter be made. At present, however, it must be noted that—

1. It is never found to any extent in the interior of the trunk.

2. It does not exist in poisonous plants, or in those with a milky or viscid sap.

3. Its proportion is greater in young than in old plants.

4. It is transformed into a bitter principle, as the plant increases in age.

5. It exists most abundantly in the cortical layers of the bark, and is usually altogether absent in the epidermis.

6. The proportion of tannin in barks varies with the season, and decreases as the severity of the weather augments.

7. The two extremes of quantity are attained in winter and spring.

PREPARATION OF TANNIN FROM NUTGALLS.

The liquor or infusion of bark which is used in the process of tanning, contains not only tannin, but gallic acid, extractive, and other principles of the plant, soluble in water. In order to present a clear understanding of the subject, we proceed to describe the various methods by which tannin may be separated from the other constituents.

Processes.—1. Proust first attempted to obtain pure tannin from nutgalls, by macerating them in water, and treating the strained infusion with a solution of muriate of tin until it ceased to produce any precipitate. The yellowish-white subsident, tannate of oxide of tin, after having been well washed, was diffused in cold water and

saturated with sulphuretted hydrogen gas, then filtered and evaporated to dryness. The evaporated, desiccated filtrate, said by the author to be pure tannin, contains also a little gallic and hydrochloric acids, and some extractive.

2. Deyeux directs that the aqueous infusion, as obtained above, be concentrated by evaporation, and precipitated with a saturated solution of carbonate of potassa. An abundant flaky precipitate, of a yellowish-white hue, will subside. This precipitate, which in drying becomes a white powder, is not, as the author believes, pure tannin, but a compound of it and gallic acid with potassa and lime, and is only partially soluble in water.

3. According to Dize, when a concentrated infusion of nutgalls is treated with strong sulphuric or hydrochloric acid, a curdy white precipitate immediately falls. Proust regarded this precipitate as a compound of tannin with the acid employed, which, for its purification, requires only to be washed with distilled water, then dissolved in pure water and deprived of its acid by saturating with carbonate of potassa. The tannin thus prepared, however, is not pure, but contains some extractive thrown down by the sulphuric acid, and probably, also, some gallic acid.

4. Mèrat-Guillot's method is to precipitate the infusion of nutgalls by lime-water, and then to treat the precipitate with dilute nitric or hydrochloric acids. Effervescence ensues, the liquor assumes a darker shade of color, and the brilliant brown residue is to be separated by filtration. This tannin is not pure, but contains, according to Davy, a compound of extractive with lime.

5. Bouillon-Lagrange's method consists in precipitating the infusion of galls, by carbonate of ammonia, washing the precipitate with cold water, and digesting repeatedly

in fresh portions of alcohol of 0.817. This process is no less defective than that of Deyeux.

6. Tromsdorff directs the infusion of three parts of powdered galls in forty parts of water, for three days, at a temperature of 70 to 100° F. The mixture is to be frequently stirred during the intervals, and then strained. This manipulation is repeated four separate times, with as many quantities of fresh water; and when the galls are exhausted, the strained liquors are to be mixed together, evaporated at a gentle heat, and again strained through a fine sieve in order to separate extractive and suspended matters. Evaporation is then continued until the filtrate attains the consistence of a jelly, when it is to be dried upon a stove and freed from gallic acid, by successive washings with alcohol of .796°. To remove the little mucilaginous matter which it contains, Tromsdorff advises that the tannin be dissolved in pure water, and exposed to the air until the surface becomes mouldy, when it must be filtered and evaporated to dryness. The residue is pure tannin, containing some sulphate of lime, which is to be separated by dissolving in water, adding carbonate of potassa, filtering off the precipitate and treating with solution of acetate of lead, which throws down a pulverulent compound of tannin and oxide of lead. After washing and drying the latter, diffuse it in water, saturate with sulphuretted hydrogen gas, filter off the sulphuret of lead which is formed, and evaporate the filtrate to dryness. The residue is impure tannin.

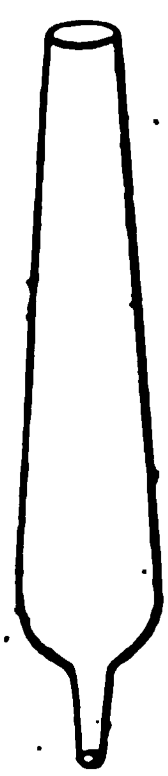
7. Serturner employs an alcoholic infusion of galls, and precipitates while warm, with a solution of carbonate of potassa. After decanting the supernatant liquid, the residue is to be washed with alcohol, then dissolved in water, the potassa to be separated by sulphuric acid, the liquor evaporated, and the residue treated with alcohol.

After precipitating the excess of sulphuric acid by means of carbonate of lime, the liquid is to be filtered and evaporated. The residue is tannin, containing only traces of gallic acid.

None of these different processes furnish tannin in a state of absolute purity. Indeed, its characteristic property of being soluble in water, and precipitating gelatine, is shared by other substances of a totally different nature, but which necessarily are comprised under the generic title of tannin; and the chemical properties of this mixed substance are those now referred to. For obtaining a much purer tannin, recent investigations have given rise to the following processes.

8. Laubert's method, which possesses advantages superior to those of any process heretofore given, consists in infusing 60 grains of nutgall in 120 grains of ether, for 24 hours, then filtering and evaporating the filtrate to dryness. The residue is tannin, containing a little gallic acid.

Fig. 1.



9. The nutgalls, in coarse powder, according to Pelouze, are placed in a long conical tube (Fig. 1.), the narrow mouth of which is loosely closed with cotton wool; and the tube thus charged is made to rest upon the rim of a stout bottle as a receiver. Common sulphuric ether is then poured upon the galls, and as it traverses the powder, it takes up both the tannin and gallic acid. The latter, however, gives a lighter and more fluid solution than tannin, and forms the upper stratum of the ethereal solution which has traversed the galls and dropped into the receiving bottle. The dense and dark colored stratum below, contains tannin. The galls are treated successively with new quantities of ether, until

they cease to yield soluble matter. The several ethereal solutions are then mixed together, and poured into a separating funnel. When the two strata have formed, the lower one containing the tannin is drawn off into a retort, distilled to save ether, then repeatedly washed with pure sulphuric ether, to remove traces of gallic acid, and evaporated over a warm sand-bath, or under the receiver of an air-pump. Ether and water are disengaged during the desiccation; the tannin swells up and becomes bulky, and forms brilliant, straw-colored, resin-like masses. The yield of this process is from 35 to 40 per cent. of tannin, of a very astringent taste, entirely free from bitterness. The ether for this process must be washed with water, for tannin is not soluble in anhydrous ether.

10. Dominé's method is a modification of Pelouze's displacement process, and has the great advantage of yielding a large product, and of being adapted for practice on a manufacturing scale.

The powdered galls are left for several days in a damp cellar to absorb moisture. At the end of this time they are transferred to a wide-mouthed jar, and are made into thin paste with commercial ether of specific gravity .750. After thoroughly mixing its contents with a wooden stirrer, the vessel is to be hermetically closed and left at rest for 24 hours. Its contents are then transferred to a strong linen bag, and subjected to gradual pressure. The syrupy liquid which exudes is caught in a receiver, and evaporated by stove heat (at 100° to 110° F.), in shallow dishes. The tannin puffs up and dries, in the form of light-colored resin-like scales.

The marc, or pressed cake, which still retains some tannin, is made to yield it on being treated in the same manner as at first, but with ether which has been mixed with six per cent. of water. The expressed liquid is

evaporated to dryness as before. The tannin obtained by this process, as well as by that of Pelouze, though sufficiently pure for the purposes of medicine and the arts, contains a little chlorophylle, volatile oil, gallic, and ellagic acids. These, according to Guibourt, may be removed by repeatedly agitating a mixture of equal parts of the tannin, water, and washed ether, and then leaving the bottle or containing vessel at rest. In due time, the liquid will separate into three strata, of which the lower contains tannin. The latter being drawn off from the other two, will, on being evaporated and dried in the usual way, yield pure tannin.

11. Tannin, according to Mohr, dissolves in ether of 0.725, and forms a syrupy liquid which possesses the peculiar property of not mixing with new portions of ether; hence it follows that tannin cannot be extracted by ether which is not hydrated.

The syrupy liquid, upon being shaken with a little water, separates after repose into three strata. The lower stratum is an aqueous solution of tannin; the middle layer is tannin in ether, and the upper one is ether containing tannin and coloring matter. The addition of a few drops of alcohol renders the ethereal solution more fluid; but too large a quantity causes the strata to commingle. Mohr, therefore, recommends that the ether used for extracting tannin from galls, be mixed with alcohol in the proportion of one part to four parts of ether. In this way, by repeated treatment of the galls with fresh quantities of alcoholized ether, until they were exhausted, he obtained seventy-eight per cent. of pure tannin.

IMPURE TANNIN.

Chemical Properties.—This substance is a brown, inodorous, transparent, friable, uncrystallizable solid, with a shining fracture, and of an acrid astringent taste, but sweetish after taste. It is heavier than water, reddens litmus, softens between the fingers, melts at a slightly elevated temperature, and is very soluble in water; but its hot solution, on cooling, drops a bright yellow powder. The solution is of a brown color, and is not affected by exposure either to air or moderate heat. It is slightly soluble in absolute alcohol, but, according to Richter, is not entirely taken up by it until the addition of 0.10 of water. According to Proust, Deyeux, and Davy, it will combine with oxygen, but becomes altered in its nature by the union. Lagrange says that this absorption of oxygen generates gallic acid. It precipitates albumen and gelatine from its solutions, and thus forms insoluble and imputrescible compounds.

Hydrochloric and sulphuric acids precipitate the aqueous solution of tannin, and the precipitate, which is only slightly soluble in cold water, but soluble in hot water and in alcohol, is generally a compound of the acid employed, with tannin.

Infusion of nutgalls is also precipitated by acetic, arsenic, malic, oxalic, and tartaric acids, and the precipitate, after being washed with cold water, and dissolved in boiling water, possesses all the properties of tannin. Nitric acid and chlorine readily destroy it, the first, by converting it into a brownish-yellow extractive matter, soluble in alcohol. According to Proust, peroxide of tin gives a similar reaction. The pure alkalies and their carbonates form with it nearly insoluble compounds.

Metals, apparently, are without any decided action upon tannin; but most of the metallic and earthy oxides combine with and render it insoluble in water; and the same oxides are insoluble, or only slightly soluble in this liquid.

Thus, baryta and lime-waters discolor solution of tannin, and precipitate a compound of tannin with the earth, which is very slightly soluble in water, and is without action upon gelatine. The peculiar precipitate of tannin with gelatine differs from the preceding in being inseparable into its two constituents. In the compounds of tannin with the alkalies or earths, the latter may readily be abstracted by means of an acid. By stirring recently precipitated magnesia or alumina into a solution of tannin, tannates of the earths are produced; these are insoluble in water and decomposable by acids which eliminate the tannin and leave it in solution. If infusion of nutgalls is treated with baryta, strontia, or lime-water, the resulting precipitate is olive-colored, and composed of tannate and gallate of the earth united with extractive. By boiling the magnesia in the infusion, the precipitate which forms is dirty yellow, insoluble, and composed of tannin, extractive, and magnesia; the gallate of magnesia, simultaneously generated, remaining in solution and imparting to it a greenish color. Albumen in small proportions gives similar reactions. In larger quantity, it carries down all the constituents of the infusion. The alkaline and earthy carbonates also throw down tannin and extractive from the infusion. The gallate formed remains in solution and imparts a greenish color.

Solution of tannin precipitates many of the metallic salts. The strength of the solution, as well as the character of the salt, has an important influence in the re-

action. In copper solutions the precipitate is olive-green, and in the state of deutoxide.

In those of the protosulphate of manganese it is a bright green.

In those of nitrate of mercury it is a bright yellow,

In those of titanium it is blood red.

In those of deutoxide of iron it is of a bluish hue.

In those of peroxide of iron it is grayish black.

Tannin also unites with various kinds of bitter principles, with starch, gluten, woody fibre, albumen, caseine, the coloring matter of blood, osmazome, animal mucus, &c., forming with them insoluble or only slightly soluble compounds.

By heat it swells up, decomposes, and when distilled gives an acid liquor, which blackens iron solutions, owing to the formation and volatilization of pyrogallic acid. A little empyreumatic oil passes over at the same time, and the residuum in the retort is a bulky charcoal, amounting, according to Proust, to .0263 of the tannin employed.

Varieties.—Notwithstanding the assiduous labors of the numerous chemists who have investigated the subject, it was a long time before tannin was separated in a pure state. Its intimate connection and combination with the extractive matter was the chief impediment to its separation; and the differences observed in specimens of tannin were owing in part to the nature and properties of this impurity.

The least impure was that extracted from grape-seed, which precipitates gelatine white. Gelatine is precipitated yellow by tannin from sumach; deep red by tannin from cinchona; and dark brown by that from catechu.

That from Brazil wood, the hematine of Chevreul, forms with gelatine a precipitate very soluble in water.

This substance seems to partake equally of the properties of tannin and of extractive matter.

Proust affirms that there are many kinds of tannin in plants, just as there are many kinds of resin; but it is possible that the varieties arise from combinations of this body with the substances before mentioned. It is also known that, in many instances, the analogy between tannin and gallic acid, is such that it is difficult to separate the former entirely from the latter; and, moreover, that tannin is convertible, under certain circumstances, into gallic acid. For example, an infusion of nutgalls, will, by protracted exposure to air, have its contents of tannin mostly transformed into gallie acid.

I. *Tannin from Catechu.*—Davy recommends the following method of extracting tannin from catechu. The alcoholic tincture is to be evaporated, and the residue exhausted with water and evaporated to dryness. This tannin, though astringent at first, has a sweetish after taste; is soluble in alcohol and in water, with a deep brown color, which is heightened by ammonia, potassa, soda, and magnesia, without any precipitate being formed. Sulphuric and hydrochloric acids give a light brown precipitate. This tannin does not throw down the protoxide of iron, but precipitates the deutoxide of an olive-green color. Starch, gluten, lignin, gelatine, albumen, &c., form with it an equally insoluble precipitate.

II. *Tannin from the Bark of Trees, Sumach, Gum Kino, &c.*—The astringent matter of vegetables, though indiscriminately designated as tannin, presents differences which are unimportant as respects its application to tanning purposes, but materially affect its chemical habitudes.

Heretofore, tannin has been classified into two varieties, one of which is distinguished for giving a bluish

black, and the other a dark green precipitate with per-salts of iron.

Berzelius and other chemists attribute this difference to accidental impurities; but Glenhouse thinks that the dissimilitude as to the color of the precipitates produced by the tannins of different sources in persalts of iron, is a chemical peculiarity, indicating that they are not identical. Moreover, tannin from oak bark, and certain other sources, unlike that from galls and sumach, does not yield pyrogallic acid by destructive distillation.

The following is a list of the chief varieties of tannin, classified in accordance with their relations to the per-salts of iron:—

1. *Tannin which forms a Blue Precipitate in Solutions of Persalts of Iron.*—Tannin from nutgalls, oak, poplar, beech, hazel, chestnut, maple, horse-chestnut, cherry, apricot, plum, elder, and other barks; sumach and log-wood, from the roots of *lithrum salicana, iris pseudacorus, geum urbanum* (Avens); *polygonum bistortum* (bistort); *alchemilla vulgaris* (ladies mantle); from the leaves of the *arbutus uva ursi* (bear-berry); *amothera biennis, geranium pratense;* from the husks of the *cæsalpina coriaria;* from lentils, &c.

2. *Tannin which forms a Green Precipitate in Solutions of Persalts of Iron.*—Tannin from catechu (juice of the *mimosa catechu*); gum kino (juice of the *coccoloba uvifera*); most of the cinchona barks; horse-chestnut bark; the roots of the *rumex aquaticus* (water dock); *tormentilla erecta* (septfoil); *krameria triandria* (rhatany); *polypodium filix mas* (male-fern); tea, and badian, a species of anise; the leaves of *salvia officinalis* (sage), and of *arnica montana* (Leopard's bane), and in date-stones.

III. *Artificial Tannin.*—Hatchett first discovered this substance in 1800, while experimenting upon the slow

carbonization of plants, and in the following year communicated his results to the Royal Society of London.

First Variety.—Is prepared by digesting powdered charcoal with dilute nitric acid, until solution ensues. The proportions are

Charcoal	1 part by weight.
Nitric acid of sp. gr. 1.40 .	5 parts "
Water	10 " "

The acid and water are mixed together, a part is poured upon the charcoal, and heated along with it in an open flask; lively effervescence, and escape of nitrous fumes ensue. After two days, the residue of the acid is added, and digestion continued until the entire solution of the charcoal. The resulting liquor is of a deep brown color and transparent. By evaporation to dryness, it leaves artificial tannin, as a brown mass, containing a slight excess of acid, which is to be removed by repeated treatment with water, and evaporation to dryness at a gentle heat. The product amounts to 1.2 parts. Any greater quantity is, according to Hatchett, owing to the presence of water.

Chemical Properties.—Artificial tannin is a brown inodorous solid, with a vitreous fracture, and bitter astringent taste, and is very soluble in water. It dissolves, also, in alcohol of .800, according to Thompson, and therein differs slightly from ordinary tannin. Its aqueous solution forms, with gelatine, a brown precipitate, insoluble in hot or cold water; and lighter or deeper in color in proportion to the strength of the solution. This compound consists, according to Hatchett, of 36 tannin and 64 gelatine in 100 parts. With sulphuric and hydrochloric acids it gives an abundant brown precipitate, soluble in boiling water; the gelatine being precipitated. Nitric

acid dissolves it unaltered, whereas every other variety of tannin is decomposed by it.

It combines with potassa, soda, and ammonia, forming solutions which deepen in color, and become cloudy in a few hours. With carbonate of potassa, the behavior is similar, except that, after a time, instead of mere cloudiness, a magma is precipitated from the solution. If the ammoniacal solution be evaporated to dryness, the aqueous solution of the residue will not precipitate gelatine unless the ammonia retained in it is first removed by neutralization with hydrochloric acid. The alkaline *earths*, such as lime, strontia, baryta, and magnesia, form, with artificial tannin, precipitates very slightly soluble in water. The metallic oxides are also thrown down from their solutions by artificial tannin, and generally of a chocolate color.

Heated gradually in a retort, it yields at first water, and afterwards nitric acid, ammonia, carbonic acid, and another gas, which is probably nitrogen. The residuum is a charcoal, amounting to 0.425 per cent. of the tannin subjected to distillation.

According to Chevreul, this tannin is a compound of nitrous or nitric acid, with a carbonaceous matter.

Hatchett remarks that all kinds of carbon, whatever their source, will yield artificial tannin by the action of nitric acid. Other substances will also furnish it. Vegetable carbon, however, is the most convenient and prolific source.

Second Variety.—This is prepared by treating indigo, resins, and similar substances rich in carbon, with nitric acid, in the manner above directed. The solution of indigo thus made, gives a very bitter orange-colored residue, soluble in water. It forms an insoluble com-

pound with gelatine, reacts with metallic salts more feebly than tannin, and contains nitric or nitrous acid.

Third Variety.—Is obtained by dissolving camphor or one of the resins in sulphuric acid, and digesting until the solution becomes black. Cold water is then added. The black powder which precipitates is to be digested in alcohol and the solution evaporated to dryness. The brown residue is soluble in alcohol and water, forms an insoluble precipitate with gelatine; and reacts feebly with persulphate of iron. According to Chevreul, this variety of tannin contains hyposulphuric acid.

IV. *Tannin from various Sources.*—Having shown that many substances by combination with certain acids yield either natural or artificial tannin, it is more than probable that tannin is not an immediate vegetable principle, but a true compound of a peculiar substance, and an acid, with more or less of extractive matter, and thus constituting the different varieties of natural tannin.

1. Thus the tannin from nutgalls, oak bark, sumach, willow, horse-chestnut, cherry, &c., is united with a greater or less amount of gallic acid, from which it is difficult to separate it entirely. The older the plant, the smaller the quantity of tannin, and consequently the more of gallic acid is contained in it.

2. The artificial tannins are always combined with nitric or sulphuric acid.

3. It is also in the acid fruits, such as the pomegranate, that tannin exists; and generally, associated with gallic acid, and the vegetable acid of the fruit, which possibly may be the source of the tannin.

Chemists reckon four varieties of tannin.

1. *Natural tannin*, comprising several species originating from the different proportions of extractive and gallic acids.

2. *Artificial tannin*, obtained by the action of nitric acid upon charcoal.

3. *Artificial tannin*, obtained by the action of nitric acid upon indigo and the resins.

4. *Artificial tannin*, obtained by the action of sulphuric acid upon the resins and camphor.

PURE TANNIN.

Chemical Properties.—Pure tannin is colorless, inodorous, very astringent, and largely soluble in water. This solution reddens litmus, and hence its acid reaction has procured for it the name of tannic acid. Moreover, it decomposes the alkaline carbonates with effervescence, and as the solution forms with most of the metallic solutions, precipitates which are true tannates, it is entitled to be ranked among the acids. Solutions of the protosalt of iron do not disturb this solution, unless both are concentrated; but those of the peroxide give an abundant blue precipitate. This precipitate is formed only by the excess of acid, for the portion first added is decomposed in reducing the peroxide to protoxide of iron, and the precipitate which is eventually produced, is a mixed compound of proto and per tannate of iron.

Alcohol and ether dissolve tannin, but by no means so largely as water; their solvent power decreasing in proportion as they approach the anhydrous state. These solutions, by prolonged exposure to the air, absorb oxygen and deposit crystals of gallic acid. *Apotheme* is also an accompanying product of the slow conversion of tannin and tanning solutions by exposure to air. It is a dark brown substance soluble in water, and is the source of the objectionable color of several kinds of leather.

As before observed, tannin has not been obtained in a

crystallized form, although attempts have been made with various solvents. When burned upon platinum foil, it leaves no residue.

A concentrated solution gives an abundant white precipitate, with sulphuric, hydrochloric, nitric, phosphoric, and arsenic acids; but not with oxalic, tartaric, lactic, acetic, citric, succinic, and selenious acids. Nor does sulphurous acid gas cause a precipitate. By being heated with nitric acid, tannin is rapidly decomposed with the evolution of nitrous fumes, and converted into crystals of oxalic acid.

The salts of cinchona, quinia, brucia, strychnia, codeia, narcotina, and morphia, form, with solution of tannin, white precipitates, very soluble in acetic acid, but only slightly in water.

Poured into solutions containing an excess of gelatine, it produces a white opaque precipitate, soluble, particularly by heat, in its own liquid. On the contrary, when the tannin predominates, the precipitate, instead of dissolving when heated, collects into grayish elastic coagula. In either case the liquid, when filtered, is colored deeply blue by the persalts of iron.

The insolubility of the compound of tannin with gelatine is no guarantee of the purity of the former or of the absence or presence of gallic acid. Pelouze determines these facts by leaving the suspected tannin in contact with a piece of hide freed from hair and prepared for the tan-vat. After a time, during which the liquid is repeatedly stirred, it is filtered, when, if the tannin is pure, there is no residue left uncombined with the hide; and the water used as menstruum does not give the slightest color with salts of iron, and moreover is tasteless, and evaporates without residue. If the tannin contains the slightest

trace of gallic acid, then the liquid is perceptibly tinged of a blue color by the salts of iron.

Gelatinous alumina, when mixed with solution of tannin, is rapidly absorbed, and produces an insoluble compound. The supernatant liquor does not color the salts of iron blue. Gallic acid behaves similarly.

At the temperature of boiling oil (630° F.), tannin is decomposed into water, carbonic acid, and an abundant residue of metagallic acid, or, in other words, the same products as from gallic acid. But with tannin, whatever the care observed in maintaining the temperature uniformly at as low a degree as will suffice for the reaction, the generation of a notable quantity of metagallic acid is unavoidable.

Tannin, as formerly prepared, in an impure form, was composed, according to Berzelius, of

Carbon	52.69
Oxygen	43.45
Hydrogen	3.86
	100.00

The more recent analyses of pure tannin, by Pelouze, prove that its composition is $C_{18}H_8O_{12}$ =

Carbon	51.77
Hydrogen	3.98
Oxygen	44.25
	100.00

CHAPTER IV.

GALLIC ACID.

GALLIC ACID was first obtained by Scheele, in 1786, from nutgalls, whence its name. It exists also in the cypress nut, arnica flowers, white hellebore, meadow saffron (*colchicum autumnale*), and in a large number of astringent barks, as a concomitant of tannin, but not in any considerable quantity. To be obtained abundantly, the assistance of active chemical agents is necessary.

PREPARATION.—1. *Scheele's Process.*—A strong aqueous infusion of nutgalls is made, and after being filtered, is exposed for some time at 70°, to the action of the atmosphere. Gradual fermentation ensues, and the tannin is more or less transformed into gallic acid; a mouldy scum being simultaneously generated. After two months the scum is removed, and the yellow or grayish deposit at the bottom of the vessel is separated from the liquid, dissolved in boiling water, filtered, and cautiously evaporated and set aside, in order that the gallic acid may crystallize upon cooling. Solution in water, filtration through animal charcoal, and recrystallization, will remove all impurities from the acid.

2. *Fiedler's Process.*—Three hundred grains of powdered nutgalls are to be boiled in five thousand grains of water, and filtered. To the filtrate, add six hundred grains of alum, the alumina of which has been pre-

cipitated by carbonate of potassa; stir the mixture, leave it at rest until the next day, and then filter. Wash the precipitate with warm water, until what passes through ceases to blacken sulphate of iron; mix the wash liquors, concentrate by careful evaporation, and set aside. The gallic acid crystallizes, on cooling, in fine needles.

3. *Ure's Process.*—Add muriate of tin to a strong infusion of nutgalls until it ceases to give a precipitate; filter, diffuse the precipitate in water, treat with a stream of sulphuretted hydrogen gas; filter, and evaporate the filtrate. Gallic acid will crystallize out on cooling.

4. *Braconnot's Process.*—Powdered nutgalls are to be drenched with water and exposed to the air at a temperature of from 70° to 75°. A quiet reaction ensues, and the mixture becomes pasty. This paste is subjected to pressure, and is then heated with boiling water, which dissolves out the gallic acid and yields it in impure crystals by evaporation. It may be freed from color by solution in water, filtering through bone-black, and recrystallization.

5. *Kent's Process.*—E. N. Kent obtained gallic acid from ink which had been exposed to the air, by agitating it with an equal volume of sulphuric ether devoid of alcohol, allowing the two strata of liquids to separate by repose, decanting the ethereal stratum, and distilling nearly to dryness. The residue, on cooling, deposits crystals of gallic acid. The ether, in this process, takes up gallic acid to the exclusion of the other constituents of the ink.

6. *Wetherill's Process.*—Thirteen drachms of dry tannin are to be boiled with twenty-two fluidounces of sulphuric acid of 1.84°, diluted with four times its volume of water. Crystals of gallic acid are deposited, the pro-

duct amounting to upwards of 80 per cent. of the tannin employed. This process is founded upon the hypothesis that gallic acid differs from tannin only in containing water. The separation of this constituent is effected, in the above process, by the sulphuric acid.

PROPERTIES.—This acid, when pure, is in very white silky needles, which are unalterable in the air. It is inodorous, of an acid, slightly astringent, but sweetish taste, and reddens litmus. It dissolves in 100 parts of cold and in 3 of hot water. This solution, by exposure, becomes covered with mould, and spontaneously decomposes and turns brown. It is also soluble in 4 or 5 parts of cold, and in 1 part of hot alcohol. The spirituous solution, though more permanent than the aqueous, also yields to the decomposing action of the atmosphere, as well as to that of light; for, even if the containing vessel be closely stoppered, the liquid soon becomes colored. By a gentle heat it may be sublimed, and it is this mode which Deyeux recommends for obtaining it pure. At a red heat, it is partially decomposed. The aqueous solution of gallic acid, upon treatment with potassa, soda, or ammonia, assumes a reddish-yellow color, which turns to deep brown upon exposure to the air, probably from absorption of oxygen. By the use of alcohol as a solvent, and certain precautions, definite, crystallized, and soluble compounds of the acid with these bases may be formed. If the acid is associated with tannin, it decomposes nearly all the permanent metallic salts. With baryta, strontia, and lime, it forms slightly soluble compounds. Its affinity for magnesia is very strong, and the compound which it forms with that earth is insoluble in water, but soluble in excess of acid. Gallic acid is also neutralized by alumina.

Gallic acid gives

An *orange-yellow* precipitate with the soluble salts of *mercury*.

A *brown* precipitate with the soluble salts of *copper*.

A *lemon-yellow* precipitate with the soluble salts of *bismuth*.

A *white* precipitate with the soluble salts of *lead*.

A *deep blue-black* precipitate with the soluble salts of *peroxide of iron*.

This last per-compound of iron is the basis of black ink and of black dyes. Its characteristic behavior with iron renders gallic acid an efficient reagent for the detection of salts of that metal. With protosalts of iron, it gives no color. Pure gallic acid, when free from tannin, does not produce any change in solutions of gelatine or alkaline salts. It is consequently of no value for tanning purposes, and proper precautions must be observed to protect the tan liquor from decomposing influences, so as to prevent the loss that would accrue by the conversion of its tannin into gallic acid, or other equally valueless derivatives. The tannin from galls and sumach is particularly susceptible in this respect; the malic acid of the latter serving as a ferment to promote the transformation. The only service of gallic acid in tanning is to swell the hides which have been cleansed in lime-water, and thus facilitate the penetration of the ooze. For this purpose, they are suspended in spent liquors, which always contain gallic acid, and afterwards transferred to the strong liquor. Sulphuric acid would answer the same purpose, and is frequently employed.

By dry distillation in a retort over an oil bath, heated cautiously to, and maintained at 420°, it gives off pure carbonic acid gas, and a white sublimate of pyrogallic

acid in brilliant crystalline plates, which line the dome of the retort. No water or empyreumatic matters are formed; nor is there any residue remaining. If, however, the heat of the bath be rapidly increased, so as to make the oil boil, carbonic acid is given off instead of the crystalline sublimate; water distils over, and a brilliant black mass remains in the retort. This latter resembles carbon in appearance, and is tasteless and insoluble, and being a true acid has been termed by Pelouze the *metagallic*.

The composition of crystallized gallic acid, according to Pelouze, is $C_7H_3O_5+HO$=

Carbon	50.10
Hydrogen	3.64
Oxygen	46.26
	100.00

ELLAGIC ACID.

This title has been given by Braconnot to a substance simultaneously formed with gallic acid, by the protracted exposure of moistened galls to contact with air. Gallic acid is dissolved out with boiling water; and the residue treated with dilute potassa lye to extract the ellagic acid. Dilute hydrochloric acid added to this lye throws down the acid in yellow powder. It is tasteless, almost insoluble, slightly reddens litmus, and forms crystalline salts with the alkaline bases.

The following is a table of the various derivatives of tannic acid ($C_{18}H_8O_{12}$) :—

1. *Oxytannic acid* ($C_{18}H_8O_{14}$), generated by the combined action of potassa and the atmosphere.

2. *Melanotannic acid* ($C_{14}H_6O_9$), generated by the joint action of potassa, air, and heat.
3. *Melanogallic acid, Metagallic* ($C_{12}H_3O_3$), by the sudden action and continuance of a temperature of 480°.
4. *Gallic acid* ($C_7H_3O_5$), by the action of air and water alone, or by the joint action of heat, water, and sulphuric acid.
5. *Ellagic acid* ($C_7H_2O_4$), by the action of air and water.
6. *Paraellagic acid* ($C_7H_2O_4$), by the joint action of water, sulphuric acid, and a temperature of 285°.
7. *Pyrogallic acid* ($C_6H_3O_3$), by sublimation of galls, or of gallic acid at 410°.

As this acid plays no part in tanning, it is unnecessary to extend the description. Pelouze's formula for it is $C_7H_2O_4+HO=$

Carbon . . .	55.69	Anhydrous.
Hydrogen . . .	2.48	
Oxygen . . .	41.83	
	100.00	

CHAPTER V.

EXTRACTIVE.

THE opinion of chemists generally is adverse to the consideration of extractive as an immediate principle of plants. It is rather a mixture of acid and of coloring and nitrogenous matters. Albumen, tannin, starch, gluten, &c., may also be constituents according to the source of the extractive. Strictly speaking, extractive does not exist as such in vegetable substances, but is generated by the action of heat, the oxygen of the air, or by chemical agents upon the constituents of the plant. Consequently, it is not of uniform composition, but varies in its chemical characters.

The older chemists applied the term "*extract*" to the incongruous mixture obtained by evaporating the juice or aqueous infusion of plants to inspissation. The application of the term was afterwards extended to the residue resulting from the evaporation of alcoholic or ethereal solutions; but it is now limited to a peculiar body contained in these extracts, and is still considered to be an independent principle by a large number of chemists.

Hermbstadt directed the evaporation to dryness of an infusion of saffron, as his method of obtaining it in a state of purity; but the product thus obtained could not be other than an aqueous extract.

The extractive principle is soluble in water, and the liquid, which is always colored, yields by evaporation a deep brown, brittle extractive of a bitter taste, soluble in alcohol, but almost insoluble in ether. When oxidized, it is insoluble in water; chlorine precipitates it from its solutions in dark yellow flakes, termed by Saussure *Apotheme;* it is also precipitated by strong sulphuric and hydrochloric acids. With most of the metallic salts, it forms insoluble compounds; and by distillation yields an ammoniacal liquor.

Deyeux and Vauquelin found it in the sap of all the trees which they examined. It, or rather its constituents, forms a part of the barks of all trees which have as yet been analyzed. Davy found it in numberless trees, and especially in the bark of the oak of the Leicester and common willows, Spanish chestnut, elm, &c. It exists also in the catechu, senna, and Peruvian bark, &c. In fact, according to Thompson, extractive is always an associate of tannin. Still, we adhere to the opinion that extractive is a compound of several vegetable principles, varying in character with the plant whence it is obtained, and thus more or less influencing the operation of tanning.

CHAPTER VI.

TANNING MATERIALS.

TANNING JUICES.

The sap of a plant is its life-juice, which starts into motion as soon as the genial warmth of spring arouses it from its winter torpor. It ascends from the roots and is the source of all the secretions of the plant. In its original and natural state, it consists of gaseous and earthy matters dissolved in water; but in coursing the permeable tissue or sapwood of the trunk, it takes up other substances. These serve as nourishment to the plant, which assimilates them by the action of its vital chemistry. The sap is a clear, transparent, colorless liquid, sometimes insipid, occasionally sweet, and nearly always acid. Confined in a bottle, its fermentation becomes so active as to drive out the cork; it has then acquired acidity, and is more or less turbid. By exposure to air, it becomes yellow and brown, and deposits flakes of an albumino-extractive character.

Vauquelin and Deyeux, who made numerous analyses of saps, found tannin in the following:—

1. In the sap of the beech-tree (*fagus sylvatica*). The analyses were made in March and at the end of April. During the latter month, it was of a fawn red color, had a tan-like taste, and slightly reddened litmus. In

either month it was composed of much water; tannin precipitating sulphate of iron black; mucus and extractive matters; acetates of potassa and alumina, and gallic and acetic acids.

Tannin is also found in the sap of the oak, and probably in that of many other trees.

As soon as the sap reaches the leaves, it undergoes various transformations, and is converted into liquids which circulate in vessels returning towards the roots. These liquids differ in their nature. Some are saccharine, and others mucilaginous, gummy, resinous, oily, milky, astringent, &c.

A large number of these vegetable saps contain tannin, and we will name two which have been analyzed.

1. The sap of an old horse-chestnut, dried upon the bark, and having the appearance of chalk, was found to contain tannin, which gave a green color with the sulphate of iron.

2. The inspissated juice of the cachou, known under the names of catechu, *terra japonica.*

CATECHU, TERRA JAPONICA, OR CUTCH.

This is a product of the fruit of the *mimosa catechu,* obtained by evaporating the decoction. Catechu is imported from Calcutta, and several varieties are found in commerce.

1. *Cake Catechu.*—This variety is brought to us in circular, plano-convex cakes, with rounded edges, the size and weight of which vary from two to six inches in diameter, and from several ounces to two pounds. Externally they are dark brown and smooth, internally always brown, frequently dark, sometimes blackish, and rarely of a light yellow or chocolate color, and more or

less cellular. The fracture is smooth in the compact parts, and rough or spongy in other portions. This variety is often of good quality.

2. *Pegu Catechu.*—This derives its name from the province in Burmah, whence it is obtained. It comes in masses of one hundred pounds' weight, but as met with in the shops is in angular irregular fragments, in double layers, with leaves intervening. This is an excellent quality of catechu, and is remarkable for its compactness, shining fracture, and deep brown color.

3. *Bengal Catechu* is originally in the form of quadrangular cakes about two or three inches long and broad; but as found in market, is in fragments. It is rusty brown externally, and dark brown or brownish gray internally, and has a rough, dull fracture.

4. *Bombay Catechu* occurs in globular lumps, of the size of an orange, flattened, and two pieces generally adhering together. It resembles the Bengal catechu in color and fracture.

5. *Gambir.*—This is an astringent extract, imported from the East Indies under the name of *terra japonica.* It is prepared from the *uncaria gambir,* or *nauclea gambir,* and contains, according to Esenbeck, from 36 to 40 per cent. of tannin. It is in cubes, with sides of an inch square. External color deep yellow or reddish brown, but paler within; fracture dull and earthy; taste bitter and astringent, but subsequently sweetish. Is porous, lighter than water, wholly soluble in it by boiling; swells up when heated, and leaves but little ash when burned.

6. *Arecha Catechu.*—From the *arecha catechu,* a palm of India. Obtained by evaporating a decoction of the nuts. There are two varieties, viz., *kassu,* black, astringent, and intermixed with husks; and *coury,* which is yellowish brown with an earthy fracture. The latter is

made from the nuts, which have already been partially exhausted in yielding the former.

As found in commerce, catechu is often adulterated with starch, which is readily detected by treatment with water, which will dissolve the catechu and leave the starch as residue. This residue, moreover, gives a jelly upon being boiled with water. Davy's analyses of catechu give the following results:—

	Bengal Catechu.	Bombay Catechu.
Tannin . . .	97	109
Extractive (*Catechuic acid*)	73	68
Mucilage . . .	16	13
Residue of lime and alumina	14	10
	200	200

Cooper found in *cutch*, which is a commercial name for catechu,

Water	12.8
Tannin	47.7
Extractive matter	9.2
Gummy "	13.6
Resinous "	6.8
Insoluble residue	9.4
	99.5

The white coating which invests the leather made with decoction of catechu, is catechuine or tanningenic acid, one of the constituents of the drug.*

KINO.

This is the inspissated juice of certain plants, met with in commerce, in brown, dry, shining masses or grains.

* COOPER, Phil. Mag. 3d ser. xxiv.

There are several varieties: 1. AFRICAN KINO, from the *pterocarpus erinaceus;* 2. ASIATIC KINO, from the *pterocarpus marsupium;* 3. AMERICAN KINO, from a decoction of the fibrous wood of *coccoloba uvifera.* The African, which is the most common kind, differs from the rest in coming in small, angular, glittering, black granules, giving a beautiful brownish-red powder. It consists of seventy-five parts of tannin and extractive, twenty-four parts mucilage, and one part lignin (*Vauquelin*). Kino-tannin forms a red mass, and yields no pyrogallic acid in dry distillation.

VEGETABLE FUNGI, OR EXCRESCENCES CONTAINING TANNIN.

Nutgalls.—This material is so rich in tannin that it merits an extended notice. The name of nutgall applies to the round excrescences upon the *quercus infectoria.* They are produced by the puncture of an insect called by Linnæus *cynips quercus folii,* and by Geoffroy, *diplolepsis gallæ tinctoriæ.* These excrescences, which result from a morbid action, induced as above stated, have their source in the juice of the plant, to which they are more or less similar in chemical character. The above species of oak is very plentiful throughout Asia Minor from the Archipelago to the confines of Persia, and from the banks of the Bosphorus even into Syria. It seldom attains a greater height than six feet. Its stem is crooked; the leaves are of a beautiful green color, and the acorn is two to three times larger than its cup.

The *cynips* is a small, hymenopterous insect, with a yellowish body and brown antennæ. It pierces the young boughs and then deposits its eggs. This prick or wound inflames the surrounding vessels and causes a swelling, which in two or three days results in a tumor-

like excrescence called *nutgall.* The eggs grow with the increase of the galls, and maintain the inflammation until the young are hatched, when they eat their way out from the cavity in the centre of the nut. The most perfect galls are those harvested before the larvæ have become matured. Those collected at this period, approach the size of a cherry, and are known in commerce as green, blue, or black galls, while those gathered later are called white galls.

The *green galls* have a dark green or bluish color, sometimes inclining to brown; are hard, compact, and heavy, with pointed excrescences on their surfaces. Their taste is very astringent and bitter. These galls are of the best quality, as they are the richest in tannin. They are brought from Aleppo, Smyrna, and the interior of Asia Minor.

The *white galls* have a brownish-yellow color, and are larger than the green and much lighter, owing to injuries received from the insects. They are also less bitter and astringent, and contain less tannin, and are therefore inferior.

French galls, produced by the same insect upon the oaks of that country, are round, smooth, and brownish, and as to proportion of tannin, rank between the green and white galls.

Chinese galls, are, according to Decaisne, a product of the *distylium racemosum*, growing in Japan, originating from punctures by an insect allied to the aphis. They are described in the *U. S. Dispensatory*, as "irregularly spindle-shaped bodies, often more or less bent, with obtusely pointed protuberances about two inches long by an inch in diameter at the central thickest part, of an ash color, and soft velvety feel, very light, hollow, of a slight odor resembling that of ipecacuanha, and of a bitter astringent taste."

According to Bley, they contain:—

Tannin	69.00
Resin and fat	3.00
Gallic acid, soluble salts, extractive and albumen	4.00
Starch	7.35
Lignin	8.65
Water	8.00
	100.00

The eminently astringent property of galls, and their large content of tannin, render their use very serviceable in certain operations, of which we shall have occasion to speak.

Aleppo Galls.—Guibourt's analysis of Aleppo galls shows the following composition:—

Water	11.5
Woody fibre	10.5
Tannin	65.0
Gallic acid	2.0
Ellagic acid	2.0
Brown extractive	2.5
Gum	2.5
Starch	2.0
Chlorophylle and vol. oil	0.7
Sugar	1.3
Albumen and salts	—
	100.0

Galls, therefore, contain sixty-five per cent. of tannin, while the oak bark collected in the spring gives but 0.6, and that cut in the autumn only 0.45. Braconnot, who also analyzed galls, obtained 30 of gallic acid, and

an insipid, inodorous constituent in white powder, and insoluble in boiling water, which he named *Ellagic acid*. According to this chemist, the soluble part of galls consists of gallic and ellagic acids, tannin, and oil. Istrian galls, according to Roder, contain only twenty-four per cent. of tannin.

TREE LEAVES.

1. The leaves of the different species of willow: the *salix alba* (or common white willow); *salix caprea* (water willow); *salix fragilis* (cracking willow); *salix pentandria* (red willow); *salix arenaria* (downy-mount willow); *salix Babylonica* (weeping willow); *salix aurigerana; salix grandifolia; salix Pyrenaïca* (Pyrenean willow); *salix nigricana* (black willow); *salix cæsia; salix lanceolata* (sharp-leaved willow); *salix vitellina* (yellow willow); *salix incana; salix viminalis* (Osier willow).

2. The leaves of the *sorbus domestica* (service-tree); and of the *sorbus aucuparia* (mountain ash).

3. Of the pomegranate, or *punica granatum*.

4. Of the *fagus sylvatica*, or beech-tree; and of the *fagus castanea* (chestnut-tree).

5. Of the *olea Europæ* (olive-tree).

6. Of the *mespilus Germanica* (common medlar); and *mespilus cotoneaster*.

7. Of the *cornus mas*, and *cornus sanguinea* (common dogwood).

8. Of the *corylus avellana* (hazel-nut-tree).

9. Of the *betula alnus*, and *betula alba* (common birch).

10. Of the *rosa gallica* (red rose), and *rosa semper virens* (evergreen rose), and others.

11. Of the *rubis fruticosus* (common bramble); *rubus cæsius* (dewberry); and probably also of the *rubus idæus*

(raspberry). The cloudberry (*rubus chamæmorus*) contains, according to Wolfgang, 7.3 per cent. of tannin.

12. Of the *rumex aquaticus* (yellow-rooted water dock).

13. Of the *rosmarinus officinalis* (rosemary).

14. Of the *quercus robur* (common European oak); *quercus cerris* (Turkey oak); *quercus sessiflora* (sessile-flowered oak); *quercus toza* (hoary oak); *quercus Apennina* (Apennine oak); and *quercus ilex* (evergreen oak). The leaves of the *quercus robur* contain the most tannin.

15. Of nearly all of the *Cistus* family, especially of the *cistus ledon*, or *Monspeliensis* (Montpelier rock-rose); *cistus albidus* (white-leaved rock-rose); *cistus incanus longifolius* (hoary rock-rose); *cistus populifolius, &c.* (poplar-leaved rock-rose).

16. Of the *erica vulgaris* (common heath); *erica cinerea* (fine-leaved heath); *erica scoparia; erica tetralix* (cross-leaved heath); *erica purpurescens.* According to Tournal, the leaves of the heath have not half the tanning power of oak bark, and this fact is confirmed by the abandonment of their use in England, where they were once largely employed. Oak barks, from the North of Europe, and especially from Belgium, though of inferior quality, are now substituted for them.

17. Of the *tamarix Gallica* (French tamarisk); and *tamarix Africana* and *Germanica* (African and German tamarisk).

18. Of the *cynara scolymus* (garden artichoke). It is recorded (*Bibliothèque Physico-Economique,* vol. i. 1789) that goat and calf skins, for bookbinders' use, have been tanned, in England, in a decoction of artichoke, as well as they could be done by nutgalls or willow bark. The twigs and leaves of the *cynara carduncūlus* (cardom.) are equally efficient.

19. Of the *prunus spinosa* (sloe-tree). Calfskins have been tanned in London with the leaves of this tree boiled in a decoction of barley. It is probable that small proportions of tannin are contained in the *prunus domestica* (common plum); *prunus Brigantiaca* (Briancon apricot); *prunus Armeniaca* (common apricot); in the *amygdalus communis* (sweet almond); *amygdalus Persica* (common peach); and in the *prunus cerasus*, or common cherry, and other kinds of cherry.

20. Of the *conium maculatum* (spotted hemlock). The tanning principle is prepared by macerating the powdered bark and shoots in cold water, and then boiling in a copper kettle. The bark is reboiled with fresh waters until exhausted, and the several liquors are then united and evaporated to a proper consistence.

Schrœder analyzed the fresh leaves, but as his result does not show the presence of tannin, it must either be incorrect or else there are other tanning principles.

An infusion of the *artemisia absinthium* (wormwood) precipitates gelatine in brown flakes, though Braconnot does not give tannin in his analysis as one of its constituents.

An infusion of the *gentiana centaureum* also precipitates gelatine in straw-colored flakes.

21. Of the *æsculus hippocastanum* (horse-chestnut). The hulls, as well as the young fruit, also contain tannin.

22. Of the *geranium pratense* (crowfoot-leaved cranesbill).

23. Of the *œnothera biennis* (common œnothera or evening primrose).

24. Of the *tilia Europæa* (lime-tree).

25. Of the *arbutus uva ursi* (bear-berry).

This evergreen shrub is indigenous to the mountain

regions of Catalonia, Italy, and the South of France, bu grows abundantly in this country, in New Jersey an in the northern States. It has a trailing, round, an reddish stem, and thick, oval, shining leaves, of a dee green color on the upper, and pale green on the lowe side. They are slightly odorous, and very astringent The flowers cluster at the ends of the branches, and hav red calyces and white corollæ with red lips. The frui is a small, round, red berry, containing five seeds, and ha a tart, acidulous taste. The market in this vicinity de rives its supply of leaves mostly from New Jersey. Th imported article is frequently adulterated with the leave of the cow-berry (*vaccinum vitis idœae*). The genuin leaves are of a beautiful green color, thick, oval, and les round than the fraudulent ones, which are dotted instea of being reticulated on the under surface. The genuin leaves have a strong odor and astringent taste, and give by trituition with distilled water, a cloudy, yellowis liquor, which, by filtration through sulphate of iron, pro duces a blue precipitate, and becomes almost discolored This reaction is due to the presence of tannin, the larg proportion of which renders the leaves available for tan ning.

TEA.

The tea plant, *thea Chinensis*, is an evergreen shru indigenous to China and Japan, in both of which coun tries it is largely cultivated. It has also been grow with success in South Carolina, and may yet become on of the agricultural products of that State.

There are several commercial varieties of tea: the *Hy son, Gunpowder, Imperial, Schulong, and Bohea,* classifie

under the designations of *green* and *black teas;* but Warrington's investigations (Chemist, 1851) have well established the fact that the green and black teas are from the same plant, and this strengthens the belief that there is but one species of tea plant. *Thea stricta, T. Bohea, and T. viridis,* are consequently not different species, but identical.

The color, flavor, form, and strength of the different kinds of tea in commerce, vary with the preparation and mode of manipulating. The leaves for *green teas,* are transferred to the roasting or drying pan as soon as harvested, and are at once highly heated during stirring; but those for *black teas* are left in heaps for some time, where by spontaneous heating they undergo a kind of slow fermentation, which changes the nature of their constituents and consequently their flavor. The leaves thus heated, as soon as they have withered and acquired a certain degree of fragrance, are removed to the roasting-pan. The black color is due to the oxidation of the extractive of the leaves, and not to artificial coloring matter, which is probably the same for both kinds of tea, and consists of a mixture of Prussian blue, gypsum, and turmeric. This coloring matter is called the glazing, and tea glazed to the maximum, is that variety known as gunpowder. Schulong tea is the hyson aromatized with the leaves of the *olea fragrans* (fragrant olive). The manner of rolling, and possibly the age of the leaves at the time of harvesting, constitute the difference in other varieties.

The composition of tea is shown by G. J. Mulder's analyses (*Ann. der Pharm.* xxviii.), as follows:—

	Green.	Black.
Volatile oil	0.79	0.60
Chlorophylle	2.22	1.84
Wax	0.28	—
Resin	2.22	3.60
Gum	8.56	7.28
Tannin (as in galls)	17.80	12.88
Thein	0.43	0.46
Extractive	22.80	19.88
Apotheme	traces	1.48
Muriatic extract	23.60	19.12
Albumen	3.00	2.80
Lignin	17.68	28.32
Salts	5.56	5.24
	104.94	103.50

Franck obtained 34.6 tannin from green, and 40.6 from black tea. Rochelder found *boheic acid*, also, in the latter. The amount of thein, according to Peligot, is from 2.5 to 4 per cent. The tannin of tea is similar in properties to quercitannin.

FLOWERS AND FLOWER TOPS.

1. Of the *potentilla anserina* (wild tansy).

2. Of the *agrimonia eupatoria* (agrimony).

3. Of the *eugenia caryophillata* (clove-tree), which, according to Tromsdorff, contains .13 of a peculiar tannin.

4. Of the *polygonum bistorta* (snake's weed).

5. Of the *geum urbanum* (common avens). This is a perennial European plant, which grows wild in damp and shady places. The root is a quarter of an inch thick, more or less; white interiorly, reddish exteriorly

and at the centre, and has long descending fibres. The odor of the *dry* root assimilates to that of cloves, and its taste is astringent and slightly bitter. The proper time for gathering it is the spring, and the heat by which it is dried should be low and cautiously managed.

Tromsdorff's analysis of the root shows that it is rich in tannin.

Volatile oil (heavier than water) .	0.39
Resin	40.00
Tannin (soluble in alcohol and ether, and blues iron salts)	410.00
Adraganthine	92.00
Gummy matter	158.00
Woody fibre	300.00
	1000.39

The water avens (*geum rivale*), which grows in Europe and in this country from Canada to Pennsylvania, as well as that from the Pyrenees (*geum Pyrenaïcum*), likewise possess tanning properties.

6. Of the *filix mas* (male fern). The other species of fern may also be used in tanning.

7. Of the *fragaria vesca* (wood strawberry).

8. Of the *spiræa filipendula* (dropwort).

9. Of the *hypericum perforatum* (St. John's wort).

10. Of the *filago Germanica* (common cotton rose).

11. Of the *vinca, major and minor* (greater and lesser periwinkle).

12. Of the *polygonum persicaria* (spotted persicaria).

13. Of the *plantago major* (plantain).

14. Of the *alchemilla vulgaris* (ladies mantle).

15. Of the *graphalium dioïcum* (everlasting).

16. Of the *equisetum palustre* (marsh horse-tail).

17. Of the *poterium sanguisorba* (common burnet).

18. Of the *lichen pulmonarius* (lungwort).

19. Of the *potentilla reptans* (cinquefoil); *potentilla canilescens* (Alpine cinquefoil); and *potentilla palustre* (marsh cinquefoil).

20. Of the *spiræa ulmaria* (meadow-sweet).

21. Of the *tormentilla erecta and reptans* (common and large-flowered septfoil).

22. Of the *geranium grandiflorum; g. sylvaticum* (wood cranesbill); and *g. pratense* (crowfoot-leaved cranesbill).

23. Of the *humulus lupulus* (hop plant). Lupulin, a yellowish powder, which is separated from the fruit or strobiles by rubbing and sifting, contains, according to Ives, more than 0.4 of tannin and gallic acid.

24. Of the *rosa Gallica* (red rose). The infusion of properly dried rose-leaves reddens litmus; precipitates gelatine, sulphate of iron, nitrate of bismuth, and oxalate of ammonia, thereby proving, by these reactions, the presence of an acid, a lime salt, tannin, &c.

FRUITS SUITABLE FOR TANNING.

1. The nuts of the common cypress (*cupressus semper virens*).

2. The marc of grapes (*vitis vinifera*).

3. The outer shell of the butternut (*juglans regia*).

4. Star aniseed or badiane of the French (*illicium anisatum*), which contains, according to Meisner, 3.2 per cent. of tannin.

SEEDS AND BULBS SUITABLE FOR TANNING.

1. Those of the grape contain much tannin, and give very good results.

2. Of the *hydro-sapathum* and *wild cornel*.

3. Attempts have frequently been made to use the dividivi, or leby-diby, the hulls of the fruit of the *cæsalpina coriaria*, a tree growing in Carthagena and Mexico. They contain a considerable quantity of tannin. The pods are dry and curled, about three inches long, and of a dark-brown color. The tannin of this substance, which exists wholly in the rind beneath the epidermis, gives no gallic acid upon dry distillation, but produces the same color with persalts of iron as gall-tannin. The objectionable brown color imparted to leather made with this material, may be prevented by keeping the infusion out of contact with the air during the process of tanning. This color is thought to be produced by the fermentation of the infusion.

4. The bulb of the *scuilla maritima*, a perennial plant, indigenous to Barbary, Sicily, and Spain. There are two varieties of squill, the red and white bulb; but they do not differ in properties. Before being sent to market, they are thinly sliced and dried. During this desiccation, the loss of weight amounts to 82 in every 100 parts.

Squill has a bitter, nauseous, acrid taste; and when applied to the skin causes it to inflame. It partially loses its acrimony by drying. The viscid juice which it contains reddens syrup of violets. Squill yields its active principles to water, alcohol, and vinegar. Vogel found in one hundred parts of dry squill,

Gum	6
Bitter principle (*scillitin*)	35
Tannin	24
Saccharine matter	6
Woody fibre	29
	100

According to Duncan and Buchner, the presence of tannin, in any considerable quantity, is doubtful.

5. *Valonia.*—This material comes from Smyrna and the Morea. It consists of the dried acorn hulls of the prickly-cupped oak (*quercus ægilops*). There are two varieties, the *common* and the *camata*. The latter is of the size of a cherry, and is the richest in tannin. The diameter of the common is nearly two inches.

The leather made with valonia is said to be firmer and heavier than the oak-tanned. When mixed with oak bark, it forms a very economical and advantageous material. Two pounds of valonia are required to make one pound of leather.

WOODS SUITABLE FOR TANNING.

The wood of almost every tree, the bark of which is rich in tannin, also contains it. Among others, we will name the different species of oak, the horse-chestnut, service-tree, and Pernambuco or Brazilletto.

ROOTS SUITABLE FOR TANNING.

1. The dentellaria, or leadwort (*plumbago Europæa*), a perennial herbaceous plant, growing wild in the south of France, contains, according to Tournal, a considerable quantity of tannin.

2. The male fern (*aspidium filix mas*), growing abundantly in moist and shady places throughout Europe. Its root, when dry, is externally brown and yellowish-white or reddish within. According to Morin and Peschier, it is composed of volatile and fat oils, gallic, and acetic acids, tannin, starch, resinous and coloring matters, woody fibre, &c.

3. Rhatany (*krameria triandria*). A shrub, indigenous to Peru, growing in mountainous districts, and flowering at all seasons. As found in commerce, it is in pieces of irregular shapes and size, sometimes not thicker than a pipe-stem, and at others an inch in diameter, and two or three feet in length. Occasionally, several of the stems issue from one head. The bark is of a dark yellow or brown color, readily separable from the wood, and has an astringent, nauseous, and slightly bitter taste. The woody part has less taste, and a color more approaching to red. Boiling water extracts its virtues, and this decoction, which has a deep brown color, is abundantly precipitated by the mineral acids. The alkalies only change its color to that of urine. Sulphate of iron produces a black, and acids a fawn-colored precipitate. Gelatine proves the presence of tannin. From the analyses of various chemists, we find that it is composed of tannin, woody fibre, gum, starch, saccharine matter, and krameric acid. One portion of the tannin has lost its astringency and been rendered insoluble by the action of the air; another portion exists as soluble extractive, and the remainder is normal.

Composition of Rhatany Root.

	C. G. Gmelin.	Peschier.
Tannin	38.3	42.6
Gallic acid	—	0.3
Sweet matter	6.7	—
Nitrogenous matter	2.5	—
Mucilage	8.3	—
Lignin	43.3	—
Krameric acid	—	0.4
Gum, extractive and coloring matter	—	56.7
	99.1	100.0

4. *Leopard's bane (arnica montana).*—Pfaff obtained from the root of this plant thirty-two per cent. of extractive matter analogous to tannin, and which gave a green precipitate with the salts of iron.

5. *Statice, or Marsh Rosemary.*—The Kalmucs use a decoction of statice and sour milk for tanning goat and sheep skins as materials for clothing. Tournal has drawn attention to this plant as a substitute for oak bark, in localities where that substance is not abundant. Of the several species, the *statice limonium*, contains the most tannin. Parrish found in the *statice Caroliniana* 12.4 per cent. of tannin.

BARKS.

The bark is that portion of the plant which envelops the root, trunk, and branches, and may be compared to the integument of an animal; like it, protecting the delicate organs within from external injurious impressions, and subserving other and somewhat similar purposes. It consists of four distinct layers, the *epidermis*, the *cellular integument*, the *cortex*, and the *liber*.

The *epidermis* is the thin, dry, transparent, non-elastic membrane forming the outer covering of the bark, and presenting a striking analogy to the cuticle of animal skins. As the plant grows old, this coating thickens by the superposition of internal layers, and eventually cracks—becomes detached, and falls off. The vital principle seems wanting in the epidermis, and it seldom or never contains astringent or other substances.

The *cellular integument*, or *parenchyma*, is the greenish, succulent layer, immediately under the epidermis. It is generally the seat of color, being thus analogous to the *rete-mucosum* of animals. The stems and branches of

both annual and perennial plants are invested with it; but in woody plants it is dried up and reproduced continually. The old layers remain—are pushed outwards by the new ones, and form, at length, the rigid, dry, dead covering of the old trunks of trees.

The *cortex*, or *true bark*, consists of but one layer in plants and branches only a year old; but in the older branches and trunks of trees, it consists of as many layers as they have years of age. The bark contains a large number of woody fibres running generally in a longitudinal direction. These give it tenacity, and when separated by maceration, usually exhibit a network of a regularly reticulated structure. The virtues or properties of particular plants reside chiefly in this bark, and principally in its inner layers. This is the case with certain resins and aromatic oils, with the bitter of cinchona, and the tannin of the oak and willow.

The *liber* is the inner layer of the cortex, and consists of laminæ, bound together by a cellular matter, which when dissolved by maceration in water, detaches these plates from each other. The most essential vital functions are carried on in this layer, and its destruction is generally fatal to the life of the plant, while the outer bark may be peeled off without injury to it. Advantage of this fact is taken in *girdling* trees, an operation which is not successful unless the axe is made to penetrate below the liber.

Cinnamon.—This is the bark of the *laurus cinnamomum*, from which the epidermis or cuticle has been removed by scraping. The tree is indigenous to, and abounds in the island of Ceylon; and grows also in Cochin-China, Sumatra, the Cape de Verds, Isle of France, Brazil, Cayenne, and some of the West India Islands.

Of the many varieties, the following are the most important:—

1. *Cinnamon of Ceylon.*—This is found in commerce in thin, quill-shaped pieces, the smaller of which are inclosed in the larger, so as to form concentric cylinders. These quills are met with in bundles tied together with bamboo string. It is of a light-brown yellow color, of a peculiar agreeable odor, and aromatic, pungent, sweetish taste. It is very brittle and friable. This is the most costly variety, and it owes its flavor to a volatile oil.

2. *Cinnamon of China.*—This variety, though of very good quality, is inferior to the preceding. The bark is heavier, thicker, of a deeper color, and of stronger but less agreeable taste. It is known in commerce as *cassia,* and comes in single quills.

3. *Cayenne Cinnamon.*—Of this there are two sub-varieties. The first is that from trees of Ceylon stock. It is paler and thicker than that from Ceylon, owing, as Guillemin says, to the too great age of the branches from which it is taken. The second is the product of a cinnamon-tree introduced from Sumatra, and is very similar to that from China. It is thick, of a very strong taste and smell, and very mucilaginous.

Birch Bark.—This is the bark of the *betula alnus,* a tree which abounds in the dry, barren portions of the Middle States, and grows to a great height. The epidermis consists of thin, white layers, which in ancient times served as a substitute for writing-paper. The inner bark is astringent, and is used for tanning "Russia" leather. According to Davy, it contains 6.75 per cent. of tannin. Distillation *by descent* yields a fragrant brown oil, to which the Russia leather owes its odor and durability.

Chestnut Bark.—We have already mentioned the chest-

nut-tree. The American species (*castanea vesca*) grows in gravelly or sandy soils, and yields a bark which contains upwards of 4.0 tannin. Leather tanned with it is said to possess greater solidity and flexibility than that made with oak bark.

Horse-chestnut.—This tree is the *æsculus hippocastanum*, indigenous to America, but cultivated in Europe. It contains, according to Davy, 1.875 per cent. of the kind of tannin which colors the salts of iron green. The American variety is known as *Ohio buckeye*.

Sassafras.—The bark of the root of the *laurus sassafras* consists, according to Reinsch, of

Water	90
Essential oil	8
Fatty matter	8
Balsamic resin and wax	50
Sassafride } extracted by	92
Tannin } strong alcohol	58
Sassafride, Tannin, and Gum } extracted by weak alcohol	68
Soluble albumen	6
Gum, coloring matter, and salts	30
Fecula, tannin, &c. (extracted by boiling water)	54
Fecula, tannin, &c., dissolved out by caustic potassa lye	289
Lignin	247
	1000

Larch Bark.—The larch-tree, known also as *cedar of Lebanon*, is a beautiful tree, much valued for its timber. There are three varieties: the *abies larix*, or common

white larch, indigenous to Germany; the black (*L. pendula*), and the red (*L. microcarpa*), natives of North America, but all largely cultivated in the mountainous parts of Scotland. Its bark contains nearly two per cent. of tannin. It is mostly used for tanning *basils*, an inferior quality of sheepskins.

The American larch, or so-called *hackmatack* or *tamarack*, is doubtless one of the above varieties. It abounds in Newfoundland, near the St. Lawrence, and as far south in the United States as the northern part of Pennsylvania. The bark of the trunk is smooth, but rugged on the smaller branches.

Hemlock Spruce, or *Abies Canadensis*.—This tree is natural to the coldest regions of America, and constitutes three-fourths of the evergreen woods in Nova Scotia, New Brunswick, Maine, Vermont, and part of New Hampshire. It is less common further south; but is found in the middle and southern States on the Alleghanies. It grows to a height of 70 to 80 feet, with a uniform circumference, for two-thirds of its length, of 6 or 9 feet. The bark is of a gray color when young, but grows lighter when old, and is generally covered with moss. The leaves are 6 or 8 lines long, flat, irregularly disposed in two ranks, and downy at their unfolding. Its flowers, which appear in May, are preceded by cones of a dark ash color. The bark is largely used in this country as a substitute for that of the oaks in tanning. It is taken from the tree in June, and half of the epidermis is shaved off before it is ground. It imparts its red color to leather made with it, which is said to be inferior to that made with oak bark; but the two kinds united are supposed to produce better leather than either of them alone.

Hazel Bark.—The product of the *corylus avellana*, a

bushy tree, growing wild in Europe, and in our middle States, and in some countries cultivated extensively for its fruit, which is the *filbert*, or *stocknut*. Davy obtained 2.916 of tannin from it.

Beech Bark.—From the *fagus sylvatica*, a beautiful forest-tree, indigenous to the North of Europe and North America. It grows throughout the United States, and is very abundant in Pennsylvania, New York, Kentucky, and Tennessee. It is classified into two varieties, which take their names from the color of the wood: the white, or *fagus sylvestris*; and the red, or *fagus ferruginea*. The latter is very rare in the western or southern States. Beech bark is of a silvery color, and contains nearly 3 per cent. of tannin. In some localities, where oak is scarce, the white beech bark is used for tanning purposes, and makes a white but inferior leather.

Lombardy Poplar Bark.—From the *populus fastigiata*. It contains 3.12 of tannin, and makes a lighter-colored leather than oak bark, imparting, at the same time, a fragrant odor similar to that of Russia leather.

Black Thorn Bark.—This is from the sloe-tree (*prunus spinosa*) or wild plum-tree, and contains 3.32 of tannin. The black thorn of the United States is the *yellow cratægus* of botanists.

Pomegranate Bark.—The pomegranate (*punica granatum*) is a shrubby tree of African origin; but growing wild in Spain, Italy, and the West Indies. It is also cultivated in our southern States. There are two varieties, distinguished by the taste of their fruit, which is sour from one, and sweet from the other. The rind of the fruit, the flowers and bark of the root, each and all abound in tannin. The rind of the fruit, as found in commerce, is reddish-brown, hard, dry, and of a sharp astringent taste. The bark of the roots, which are com-

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pact and knotty, is thin, of a brownish-yellow color, and of a short, brittle fracture. It comes in quills, is very astringent, and, when chewed, colors the saliva yellow.

Ash Bark.—The tree (*fraxinus excelsior*), bearing this bark, abounds in our forests, and grows to a great height. Both the leaves and bark have a very bitter astringent taste. The bark contains, according to Davy, 3.3238 per cent. of tannin.

Elm Bark.—The elm (*ulmus campestris*), cultivated in the United States as an ornamental tree, yields a rough, iron-gray colored bark, of a sharp bitter taste, which contains, according to Davy, 2.706 per cent. of tannin. Some of the varieties of the elm exist in parts of the United States as forest-trees.

Cinchona Bark.—The cinchona is a South American tree, of which Guibourt has described twenty-five species, and the number is further increased by the additions of other naturalists. We shall confine our notice to those more particularly containing the tanning principle.

The most valuable kinds of bark come from the Pacific coast of South America, and are classified in commerce, according to their color, into *pale*, *yellow*, and *red* barks, all of which contain tannin.

The *pale bark*, called by the French *gray* bark, from the color of the epidermis, reaches market in single or double quills. Its taste is somewhat astringent. This bark is derived from the *cinchona Condaminea*. The *yellow bark*, in quills or flat pieces, is from the *cinchona calisaya*. *Red bark*, called, in South America, *cascarilla roxa* and *colorada*, comes also in quills or flat pieces, but the species of cinchona which bears it is unknown. The Carthagena barks, an inferior species of cinchona, also contain tannin.

All of the foregoing possess highly medicinal proper-

ties, and, on that account, are too valuable to be used as tanning material in this country.

Cork-tree Bark.—The *inner* bark of the *quercus liber*, or cork oak, a tree indigenous to, and abundant in Corsica and Spain. The tannin which it contains is similar to that from catechu, and imparts to the leather an objectionable dark color. It has twice the tanning power of oak bark, and is largely used for the purpose in Ireland and England.

Poison Oak.—The poison oak is the *rhus toxicodendron* and *rhus radicans* of Linnæus. The two were formerly considered distinct varieties, but they are only different stages of the same growth, *radicans* being applied to the creeping parasite, and *toxicodendron* to the early vine. It grows wild throughout the United States, and bears small, greenish-white flowers in June and July. This plant contains tannin, gallic acid, resin, &c., and evolves a volatile principle, which is very poisonous.

Sumach.—This tree is the *rhus glabrum*, or Pennsylvania sumach, indigenous to Asia, but growing wild in Spain, Portugal, and throughout the United States. It is a shrub of from four to twelve feet in height, with crooked stem and reddish-gray bark, and differs from the poisonous species. The new leaves are green on the upper, and whitish upon the under-surface, but they become red in the autumn. The flowers are greenish-red, and bloom in July, and the fruit, which consists of clusters of small crimson berries, ripens in the fall. Both the leaves and the bark contain tannin. So also do the warty excrescences which grow under the leaves. Sumach is used largely for tanning in this country and abroad. In some cases it is mixed with oak bark, and in others is employed alone, as in the manufacture of morocco and glazed skins, for which purpose it is pecu-

liarly adapted, by reason of its not imparting any color. It is said, however, to diminish the pliability of the leather.

There are several varieties of sumach met with in commerce. The most esteemed is the product of the *rhus glabrum* or *coriaria*, which is composed of the leaves, peduncles, and young shoots thoroughly mixed and powdered.

Sicily sumach is in high repute. It is in bright-green powder, with astringent taste and violet odor. Of the two varieties of this species, the *sumach alcamo* is preferred for morocco. The other, which is feeble in tanning constituents, is only used for dyeing (Dumas 7, 527).

French sumach occurs in grayish-green powder.

The preparation of sumach consists in sun-drying the branches, separating the leaves by threshing with a flail, and then grinding them in a mill. When packed in bags, it is then ready for the market. Sometimes the young branches are ground with the leaves for fraudulent purposes.

Willow.—The white willow (*salix alba*) is the common European willow, which is found growing in the northern and temperate parts of North America. Its bark is easily separable in the summer, and when dried, is of an ash-gray color on the upper, and of a reddish yellow on the under surface. It is brittle, with a fibrous fracture and bitter astringent taste. The bark of the branches is thin, and in drying assumes the quill form. The white willow contains, according to Davy, 2.295 per cent. of tannin, and the Leicester willow 6.86 per cent. The willow genus comprises upwards of one hundred species, nearly all of which are native to Europe or North America. The black willow (*S. nigra*) is the most common

American willow, and grows extensively in the Western and Middle States.

In the north of Europe, they use the bark of *S. alba* for tanning; and in Iceland, that of the *S. herbacea*.

The leather which is made from kid and lamb skins, owes its agreeable odor to the willow bark with which it is tanned.

Sycamore.—The bark of the *acer pseudo-platanus*, growing throughout the United States, south of Maine, and abounding in the fertile valleys of the West. It takes the name of buttonwood, sycamore, plane-tree, and water-beech, according to locality. The bark contains 2.3 of tannin.

Tamarisk.—The tamarisk (*tamarix gallica*) is a hardy shrub-plant, indigenous to Spain, Italy, and the south of France. Its leaves resemble those of the savin-tree, but are of a lighter green color. The bark is deep reddish-brown on the upper, and yellowish on the under side. Both the wood and bark have an astringent, slightly bitter taste. The bark should be taken from branches of two to four years' growth.

Winter's Bark.—The product of an evergreen tree (*drymis winteri, or winterana aromatica*), indigenous to all South America, but growing chiefly in Brazil. The bark is of a gray color, inclining to reddish, and reaches market in flat and very large pieces, or in quills of about twelve inches in length, and an inch or more in diameter. It has always the appearance of having been scraped externally, and breaks, with a grayish color of the outer fracture, while that of the internal part is reddish. It has a sharp burning taste and terebenthine odor. Henry found tannin among its constituents.

Tulip-Tree.—The bark of the poplar (*liriodendron tulipifera*) also contains tannin. This tree grows through-

out the United States. The bark is grayish-brown with the epidermis, and yellowish-white without it. It is brittle, heavy, and has a disagreeable odor, and a pungent, aromatic taste, which it loses by age.

St. Lucia Bark.—This bark is the product of the *exostemma floribunda*, and is said to be suitable for tanning.

Wattle Bark.—The bark of the different species of *mimosa*, growing abundantly in Australia and New Zealand. Sometimes a fluid extract of the bark is imported. The leather tanned with wattle bark is of excellent quality, but highly colored.

CHAPTER VII.

OAK-BARKS.

The oak-tree, from its majestic appearance, great strength, hardiness, and durability, has been termed the "patriarch of the forest," and is considered as the emblem of grandeur. It is said to live from three to five hundred years, and is the most valuable of trees for its wood as well as bark.

The oak is indigenous throughout Britain and North America. There are many species, and all contain a large amount of tannin in their bark, leaves, and fruit. The bark is gathered from May to July, because it contains more tannin in the spring than at any other season.

Skins may be converted into leather more or less perfectly, by the action of any of the vegetable substances which contain tannin; but the small quantity of it existing in most of them, and the costliness and rarity of those of which it is a principal constituent, together with the injurious effects upon the leather which often attend their use, have restricted the substitution of other substances for oak-bark, which tanners have employed from the earliest times, and which, when ground, seems to present the tannin to the skins exactly in the proportion and under the circumstances best calculated to effect their conversion into superior leather.

More than eighty species of the oak are known, of which at least one-half inhabit the United States, and the elevated portions of Mexico. The bark of all the species abounds in tannin and gallic acid, and is, or may be used in tanning; but in Europe, that of different varieties of *quercus robur*, and of the *quercus coccifera*, and in America, the bark of *quercus falcata*, *quercus rubra*, *quercus tinctoria*, and *quercus prinus monticola* are most esteemed for the purpose. We proceed to give a short account of these, and of a few other American species which are, or may be used to furnish bark suitable for the purposes of the tanner.

EUROPEAN OAKS.

1. *Quercus Robur*.—The common European oak, or British oak, as it is commonly called, is a tree of the utmost importance on account of its general distribution throughout Europe, and the excellent qualities of its wood and bark. The term *robur* is used by most authors to designate a group of closely allied species, or perhaps only varieties; the two principles of which, the *Q. pedunculata*, and the *Q. sessiliflora*, which are too much alike, in magnitude and general appearance, to require a separate description, are both widely spread. They are majestic trees, attaining the height of from sixty to a hundred feet, with trunks from six to twelve or more feet in circumference; with spreading tortuous branches and spray, and, when standing singly, with heads usually broader than they are high. The leaves are deciduous, oblong, smooth, dilated upwards; with sinuses rather acute, and lobes obtuse; stalks of the fruit elongated; nuts oblong. The leaves resemble, in form and appearance, those of the American white oak. Except in

the north of Russia, and in the limited districts of France, where the *Q. coccifera* is used, the bark from the varieties of this oak is exclusively employed in the manufacture of leather; and that from the small branches is preferred, because in them the epidermis is thinner and the cellular integument which contains the tannin is more abundant.

2. *Quercus Coccifera.*—The Kermes oak is a tortuous, branching shrub, inhabiting Spain, Portugal, and the South of France. It grows to the height of from three to four and a half feet, in close, thick tufts, or clumps, which, by the interlacing of their matted roots, consolidate the soil around them, and prevent it from being washed away by the heavy rains prevailing in its native localities.

The leaves are elliptic-oblong, rigid, smooth on both sides, with spreading, bristly, spinous teeth; fruit on peduncles; nut ovate; calyx with spreading, pointed, somewhat recurved scales. The whole plant resembles a holly in miniature; but the leaves are of a paler green.

The bark of the root is of a yellowish-brown color, and is very rich in tannin. This species of oak is chiefly known from its being fed upon by the *coccus ilicis*, a little insect, resembling in appearance a red berry, which furnishes a scarlet dye, highly valued in commerce before the introduction of cochineal; but it is also worthy of notice on account of the bark of the root, which is employed for tanning to a considerable extent in various parts of France. It is there called *garrouille*, and is said to abound in tannin, and to be used with great advantage in the tanning of a very superior quality of thick, impervious sole-leather.

AMERICAN OAKS.

3. *Quercus Falcata.*—This oak, known in Delaware, Maryland, and Virginia by the name of *Spanish oak*, and in the Carolinas and Georgia by that of *red oak*, is a large tree, inhabiting all those parts of the Union which are south of the forty-first parallel of latitude, but most abundant in the Atlantic States.

This oak is remarkable from the great dissimilitude which exists in its leaves and general appearance in different climates. In the southern States it grows to the height of eighty feet, with a trunk four or five feet in diameter; while in New Jersey it is never above thirty feet high, with a trunk four or five inches thick. The bark is thick, black, and deeply furrowed, and the wood is reddish and cross-grained, with open pores. The leaves on the trees in the South are falcate, and, as well as the young shoots to which they are attached, are covered with a thick down upon the under sides. In New Jersey the leaves are three-lobed, except a few upon the summit, which are slightly falcated. This tree fructifies once in two years. Its flowers put forth in May, and are succeeded by small, round, brown acorns, contained in scaly, shallow cups, supported by peduncles one or two lines in length. They resemble those of the bear-oak, and preserve, for a long time, the capability of germination. The Spanish oak is chiefly valuable on account of its bark, which is preferred to any other for tanning coarse leather, which it is supposed to render whiter and more supple. The quality of the leather prepared with it is said to be improved by the addition of a small quantity of hemlock bark to the tan.

4. *Quercus Rubra.*—The *red oak* is one of the most

common species in the northern States and in Canada. It is very abundant in the lower part of New York, in New Jersey, the upper districts of Pennsylvania, and along the whole range of the Alleghanies.

It grows to a large size, being often eighty feet high, and three or four in diameter. Its leaves are large and deeply laciniated, smooth and shining on both sides, and rounded at the base. On the middle or summit of the full-grown tree, they resemble the leaves of the Spanish oak, but unlike them are not downy beneath. The fructification is biennial and it flowers in May. The acorns are large and numerous, compressed at the base, rounded at the summit, and contained in flat cups, covered with compact, narrow scales.

The bark of this tree consists of a very thin epidermis, with a thick, cellular integument. It is very generally employed in tanning, but is considered inferior to that of the Spanish, black, and rock-chestnut oaks.

5. *Quercus Prinus Monticola.*—The *rock-chestnut oak* is most frequently met with in the middle and some parts of the northern States, but is rarely found along with other trees in the forest, but only on high grounds thickly covered with stones or rocks. Along the Alleghanies, it often constitutes nine-tenths of the growth upon some of the mountains. In Pennsylvania, Virginia, and Maryland, it is called *chestnut-oak*, on account of the resemblance of the bark to that of the chestnut; and on the banks of the Hudson and the shores of Lake Champlain, it is known as the *rock-oak*, from the situations in which it is found. The rock-chestnut oak, when growing in a fertile soil, is often sixty feet high, and three feet in diameter; but usually growing in sterile soil, it rarely attains these dimensions. The leaves are five or six inches long, and three or four broad; oval, and uniformly

denticulated. When opening in the spring, they are covered with a thick down; but when expanded, they are perfectly smooth and whitish beneath. The flowers appear annually in the month of May, and are succeeded by brown acorns of an oblong oval shape, and sometimes an inch in length, a third part of which are contained in spreading cups with loose scales.

When the trunk of this tree is more than a foot in diameter, it is covered with a thick, hard, deeply-furrowed bark. The epidermis is strongly impregnated with the tanning principle, which in other species resides chiefly in or under the cellular integument. The bark is esteemed as among the best for tanning, in Pennsylvania and New York; but only that of the secondary branches, and of the trunks of young trees, is employed.

6. *Quercus Tinctoria.*—The black or *quercitron oak* is a large tree, found throughout the United States, south of latitude 43°, and abundantly in the middle States, and in the upper parts of the Carolinas and Georgia. It is one of the loftiest trees of the American forests, being often eighty or ninety feet high, and four or five in diameter. The trunk is covered with a deeply furrowed bark of medium thickness, and of a deep-brown or black color, which in the North serves to distinguish it from the red, scarlet, and gray oaks, when the leaves have fallen; but as the bark of the Spanish oak in the South is of the same color, all doubt of its identity may be removed by chewing a piece of the cellular integument, that of the quercitron being very bitter, and imparting a yellow color to the saliva, which is not the case with the other. The leaves are large, deeply laciniated, and divided into four or five lobes. They are like those of the scarlet oak; but, during the summer, have their surfaces roughened with small glands which are evident to

the eye and the touch. The fructification is biennial and occurs in May. The acorns usually grow in clusters, are of a brown color, sub-sessile, and half buried in a thick, scaly cup.

The *quercitron*, so much used in dyeing, is obtained from the cellular integument; and the bark is very extensively employed in tanning, for which it is well adapted, as it is produced in great abundance and is rich in tannin. The only inconvenience is, that shoes made of leather tanned with it are apt to impart a yellow tinge to the stockings. This color of the leather does not increase its value, as has been stated by some authors, and is often removed by a particular process.

7. *Quercus Alba.*—The white oak is found throughout the United States, being widely, but unequally distributed from about latitude 46°, to Florida, and from the Atlantic to some distance beyond the Mississippi River; extending somewhat further northward in these western regions. It is most abundant in Virginia and in the middle States, particularly in the southwestern part of Pennsylvania, upon the Monongahela and its branches, where it sometimes composes nine-tenths of the forest.

The white oak reaches the elevation of seventy or eighty feet, with a diameter of six or seven feet. The leaves are regularly and obliquely divided into oblong, rounded lobes, destitute of points. Soon after unfolding, they are reddish above, and white and downy beneath, but, when full grown, they are smooth and of a light green above, and glaucous below. The leaves change in autumn to a bright-violet color, and a few of the dried leaves persist till the circulation is renewed in the spring. The tree is easily distinguishable in winter by this peculiarity, and by the whiteness of its bark. It puts forth flowers in May, which are succeeded by oval acorns,

large, very sweet, contained in rough, shallow, grayish cups, and borne singly, or in pairs, by peduncles eight or ten lines long, attached to the shoots of the season.

The bark is often variegated with large black spots, and, on trees of less than sixteen inches in diameter, the epidermis is divided into squares; on old trees, growing in moist grounds, it is in the form of plates, laterally attached. The bark is considered by many tanners to be the best for preparing leather for saddles and similar objects; but it is little employed, as that from the trunk and large limbs alone is used, and on these the cellular integument is much thinner than it is on those of the red oak. The inner bark of the small branches contains the greatest quantity of tannin.

8. *Quercus Coccinea.*—The *scarlet oak* is most abundant in the middle States, and on the mountains of Carolina and Georgia, but is found as far north as latitude 43°. It grows to more than eighty feet in height, and three or four in diameter. The leaves, which are supported by long petioles, are of a beautiful green color, shining on both sides and remarkably laciniated, having usually four deep sinuses, which are very broad at the bottom. They change with the first cold; and after several frosts become of a bright scarlet color. It fructifies biennially, flowering in May. The acorns are large, similarly rounded at both ends, and half covered with scaly cups. The tree produces galls, which are applied to the same purposes as the European galls of commerce.

The bark of the scarlet oak is very thick, and is generally employed in tanning, though it is not preferable to that of the red and gray oaks.

9. *Quercus Ambigua.*—The *gray oak* is abundant in Maine, New Hampshire, and on the shores of Lake

Champlain in Vermont. It attains a height of fifty or sixty feet, and a diameter of fifteen or eighteen inches. The leaves are large, smooth, and deeply sinuated at right angles to the main ribs. The flowers put forth in May, and are succeeded by acorns of a middling size, rounded at the end and contained in scaly cups. The wood and bark are similar to those of the red oak, and the latter may be employed in tanning.

10. *Quercus Virens.*—This species, known as the *live oak*, is confined to the vicinity of the Atlantic coast, south of latitude 37°, and of the Gulf of Mexico as far as the Sabine River, being never found more than twenty miles inland. It is commonly forty or fifty feet high, and one or two feet in diameter. The leaves are oval, coriaceous, of a dark green color above, and whitish beneath, persisting during several years, and being partially renewed every spring. It fructifies once in two years, the flowers appearing in May, and being succeeded by acorns of an oval, lengthened form, nearly black, and contained in shallow, grayish, pedunculated cups.

The bark is hard and thick, and of a blackish color. It is very excellent for tanning leather, but is not largely employed for the purpose.

The bark from a number of other species of American oaks may be and is incidentally employed in tanning, but manufacturers of leather in the United States make use almost entirely of those which have been described, and particularly of the first four kinds.

CHAPTER VIII.

BARKING OF TREES.

THE four distinct layers of which, as we have already stated, bark is composed, are not equally rich in tannin. Indeed, the epidermis contains none, and the liber very little. It exists chiefly in the inner layers of the cortex, or true bark; extractive matter predominating in the middle-colored portion. Davy found that the bark of a medium-sized oak contained 6.04 per cent. of tannin, while the external layers gave only 1.50.

Barks with thick epidermis are the least valuable in tanning ingredients.

It is a mooted point whether the quantity of tannin increases with the age of the bark. Fontenelle and Malepeyre say that the older the bark the more of tannin it contains, and in support of their opinion they cite the European and American practice of collecting the bark chiefly from the maturer trees.

The proper season for separating the bark from trees is in the spring of the year, when the sap is circulating most actively, and before the complete expansion of the leaf. Davy found that the bark of oak trees, cut in the spring, contained nearly one-third more of tannin than that obtained in the autumn, thus proving the advantage of cutting the trees in the former season. The proper time for barking the oak in this country is from the end

of April to the end of June, varying with the degree of latitude, the exposure of the locality, and the temperature of the season which has preceded the cutting. The operation should be postponed until after the usual time of harvesting the bark, if the previous winter has been uncommonly severe or prolonged, and should be anticipated, if a mild season has caused an early circulation of the sap. In our northern States, the bark does not generally acquire its full strength of tannin, nor is it proper to gather it until the middle of May, and in some places not until June. In lower latitudes, and in a warm spring succeeding a mild winter, it may be harvested as early as April. The bark of southern oaks yields generally more tannin than that of those growing in higher latitudes; and that of trees in dry and elevated places, with a warm exposure, is superior to the bark taken from oaks growing in low, damp, and shady locations. Wet seasons have likewise an influence in diminishing the tanning power of bark.

The process of barking is in general well understood. Immediately after the tree is felled, the bark is cut across circularly at the two extremities of the trunk, and is then split off in longitudinal pieces of the proper size, and dried slowly in the shade. The greatest attention should be paid to harvesting it properly, as it loses color and becomes mouldy and otherwise injured in quality, if suffered to heat or ferment. The best mode is to make what are called by foresters *temporary lofts*, about two feet wide, and long enough to hold a day's peeling of bark. These lofts are made by driving uprights of forked stakes into the ground, three feet high in the back row, and two and a half in the front, and a sloping floor is laid upon these by placing loppings between the forks of the bearers. The bark is then laid upon this floor, with

the thick ends towards the highest side; the smaller bark is placed over this to the height of six or eight inches, and the broad pieces are laid over the whole, to protect it from rain or dew. The pieces should be turned in four or five days, in order to prevent moulding; and in about ten days, they will be sufficiently dry to be stacked until wanted by the tanner. The stack should not exceed eight feet in width, in order that fermentation may not occur, and it should be covered with a roof formed and thatched like that of a hay or corn stack.

CHAPTER IX.

METHODS OF ESTIMATING THE TANNING POWER OF ASTRINGENT SUBSTANCES.

THE quality of bark may be determined by inspection; but a chemical examination alone will enable us to estimate accurately its degree of excellence.

A good bark may be recognized by its color. That is good which is white on the outer surface, and reddish in the interior: which is rough, dry, fragile, and with a clean fracture, free from fibres. The astringency of its taste, and its odor should be decisive, more particularly when it is ground.

When the epidermis and liber are dry, thick, and blackish, and channelled with large crevices, the bark is of inferior quality. These old barks are in an incipient state of decomposition; as is also the case with bark which has been long exposed to dampness.

Bark internally of a red color, which has become nearly inodorous, dingy and rusty, has likewise depreciated in useful properties.

The determination of the quality of bark by chemical means, is based upon the separation of the tannin; that component upon which its value as tanning material exclusively depends. The requisite manipulations are as follows:—

We have already mentioned the fact that a characteristic behavior of gelatine is to form an insoluble com-

pound with tannin, which is entirely distinct in properties from its constituents in their original states. Upon this reaction depends the whole theory and practice of the tanner's art.

To ascertain the relative value of barks, or tanning substances, it is only necessary to determine the ratio, by weight, of the precipitates thrown down by gelatine from aqueous infusions of equal weights of the materials. These precipitates, separated by filtration and dried, give, by the differences in weight, the relative proportions of tannin.

Davy's Process.—Davy's process is to digest 460 grains of the powdered bark in a pint of boiling water, and after a day's repose, and frequent stirring during the interval, to filter. The filtrate is then mixed with an equal volume of a liquid made by dissolving 60 grains of gelatine, or pure isinglass, in two pints of hot water, and the mixture is then filtered. The precipitate on the filter is to be dried in the air and accurately weighed. As the precipitates of gelatine by tannin, when dry, average 40 per cent. of tannin, it is easy to obtain an approximate result by calculation. For example, suppose the precipitate weighs 150 grains, then as

100 : 40 : : 150 : 60 = the amount of tannin in the 460 grains of bark operated upon, or 13.04 per cent.

Bostock is convinced that the precipitate of gelatine by tannin, in the above process, is so intimately suspended through the liquid as to render its entire separation by filtering almost impossible, a portion always passing through the filter. At the same time, the proportion of tannin which it contains is not uniform, as that which goes down first carries about 50 per cent.; while that which ensues takes scarcely any with it. Acting upon these suggestions, Bell Stephens proposed the following improvement upon Davy's method:—

Bell Stephens's Process.—Small strips of hides are to be soaked for some hours in a weak solution of tanning material, made with water at 90°. F. In from 8 to 10 hours the whole of the tannin is abstracted, and the increase of the weight of the strips, thus acquired, will indicate the precise amount absorbed by them.

The strips must be weighed in a dry state; but before they are placed in the tanning liquor, they should be softened by being soaked in warm water, and by working with the fingers, so as to facilitate the subsequent absorption of the tanning principle. When they are taken out, drying must precede the final weighing. The best skins for this essay are sound fresh ox hides, shaved to the greatest possible degree of thinness.

Though Davy's method is not faultless, it is preferable to that of Stephens, which, owing to the unequal absorption of water by the skin at different times, cannot give the exact amount of tannin.

A thorough examination of all the parts of the several species of oak at different stages of their growth, showing the comparative value in tanning principle, under different circumstances, would be interesting to the tanner as well as satisfactory to the man of science.

Warrington's Process.—The following method, as communicated by the author, is taken from the memoirs of the London Chemical Society, 1847:—

"Gelatine was selected as the basis for the estimation of their comparative value; and after several trials with various kinds of natural and manufactured gelatine, such as varieties of isinglass, glue, patent gelatine, &c., the finest long staple isinglass was found to be the most constant in its quality and least liable to undergo change.

"With this, therefore, the test solution was prepared, of such a strength that each division, by measure in the

ordinary alkalimeter tube, should be equivalent to the one-tenth or one-fourth of a grain of pure tannin, and thus the number of divisions used would indicate the proportion of available tannin, or substance precipitable by gelatine contained in any specimen. A given weight of the sample under trial was then infused in water, or, if necessary, the astringent matter extracted by boiling, and the clear liquid precipitated by the test solution until no further deposit occurred.

"It was necessary in the course of this operation to test at intervals a portion of the solution under examination, to ascertain the progress of the trial; and this, from the nature of the precipitate, was attended at first with some little difficulty; paper filters were inadmissible from the quantity of the solution they would absorb, and thus introduce a source of extensive error; subsidence rendered the operation very tedious. The plan I have adopted is as follows: A piece of glass tubing, about twelve inches in length, and about half an inch internal diameter, is selected, and this has a small piece of wet sponge loosely introduced into its lower extremity, and when it is wished to abstract a part of the fluid under investigation, for a separate testing, this is immersed a few seconds in the partially precipitated solution; the clear liquid then filters by ascent through the sponge into the tube, and is to be decanted from its other extremity into a test glass; if, on adding a drop of the gelatine solution to this, a fresh precipitate is caused, the whole is returned to the original bulk, and the process proceeded in, and so on until the operation is perfected; this method of operation is facilitated by conducting the examination in a deep glass. After a few trials the manipulation will be found exceedingly easy, and in this way considerable accuracy may be arrived at."

Table of the Average Quantity of Tannin in different Substances.

Substances.	Percentage of tannin.	Authority.
Catechu, Bombay	55.0	Davy.
" Bengal	44.0	"
Rhatany root	42.6	Peschier.
" "	38.3	C. G. Gmelin.
Kino (tannin and extractive) . .	75.0	Vauquelin.
Butea gum (*butea frondosa*, or *dhak-tree*)	73.2	E. Solly.
Nutgalls, Aleppo	65.0	Guibourt.
" Chinese	69.0	Bley.
" Istrian	24.0	Roder.
Oak, old; white inner bark . .	21.0	Cadet de Gassincourt.
" " " " . .	14.2	Davy.
" young; " " . .	15.2	"
" " colored or middle bark .	4.0	"
" " entire bark . . .	6.0	Davy and Geiger.
" " spring cut bark . .	22.0	Davy.
" Kermes; bark of the root .	8.9	"
Terra japonica, or gambir . .	40.0	Esenbeck.
Avens root (*geum urbanum*) . .	41.0	Trommsdorff.
Squill, bulb	24.0	Vogel.
Statice, of South Carolina . .	12.4	Parrish.
Birch bark	1.6	Davy.
" "	1.4	Biggers.
Beech "	2.0	Davy.
Larch "	1.6	"
Hazel "	3.0	"
Chestnut, American, rose . .	8.0	Cadet de Gassincourt.
" Carolina	6.0	" "
" French	4.0	Julia de Fontenelle.
" Spanish, white inner bark .	1.3	Davy.
" " colored or middle bark . .	0.3	"
" " entire bark .	0.5	"
" horse	2.0	Julia de Fontenelle.
Poplar, Lombardy	3.5	" "
Black thorn	3.3	Davy.
Ash bark	3.3	"
Sassafras, bark of the root . .	58.0	Reinsch.
Elm	2.9	Davy.
Sumach, Sicily	16.2	"

Substances.	Percentage of tannin.	Authority.
Sumach, Malaga	16.4	Davy.
" "	10.4	Franck.
" Carolina	5.0	Cadet de Gassincourt.
" Virginia	10.0	" "
Willow, Leicester; white inner bark	16.0	Davy.
" " colored or middle bark	3.1	"
" " entire bark	6.8	"
" " bark of the trunk	1.4	Biggers.
" weeping	16.0	Cadet de Gassincourt.
Sycamore bark	16.0	" "
" "	1.4	Biggers.
Elder "	2.3	Davy.
Plum-tree "	1.6	Biggers.
Cherry-tree "	24.0	Cadet de Gassincourt.
" " Cornish	19.0	" "
Tormentil root	46.0	" "
Cornus sanguinea of Canada	44.0	" "
Alder bark	36.0	" "
Apricot bark	32.0	" "
Pomegranate bark	32.0	" "
Bohemian olive	14.0	" "
Tan shrub with myrtle leaves, bark	13.0	" "
Service-tree bark (June berry)	18.0	" "
Cloves	15.0	Davy.
Winter's bark	9.0	Henry.

CHAPTER X.

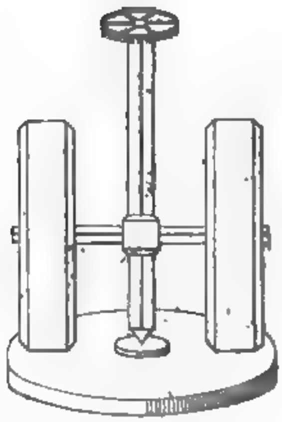
TAN, OR POWDERED OAK-BARK.

THE more finely divided a substance, the sooner and more readily does it yield to the action of the liquid which dissolves its constituents. Water, accordingly, dissolves the tannin from bark in powder much more readily than from bark in coarse pieces. The grinding of the bark for tanning purposes is, therefore, indispensable. It must not, however, be reduced to impalpable fineness, else the solvent will act upon it too rapidly. Very fine powders also form a compact mass when wet, and thus obstruct or retard the infiltration of the solvent liquid.

Bark is ground in mills varying in construction in different countries, and driven or propelled by horse, water, or steam power. In England, it is crushed between chasers, or stones. There is a mill of ingenious construction used in Salleron's tannery in France, but as its rapid motion so modifies the bark as to cause it to impart color to the hides, we omit a description of it.

In the south of France they use a vertical mill of hard stone, similar to that employed for crushing oil seeds. It consists of two vertical stones (Fig. 2), of about 7½ feet in diameter, and 18 inches in thickness. The axle of these stones is fixed in a frame which incloses an upright shaft turning upon a pivot, and fixed in the centre of a strong stone bed. Rotary motion

Fig. 2.



being communicated, imparts to each stone a double movement; that upon the other, and that which it undergoes in describing a circle upon the stone bed upon which it rolls.

The axle of each stone should be so adjusted as to allow it to be raised or lowered according to circumstances. One of the stones is placed nearer to the vertical shaft than the other, so as to give a greater extent of crushing surface beneath. Two followers press the bark forward under the stones, and a cloth is attached to the outer one, for the purpose of rubbing off any pieces of bark that may adhere to the edges of the stones.

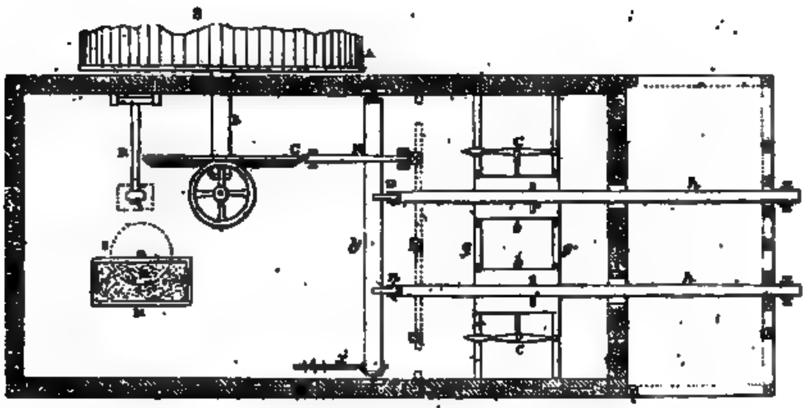
Bagnall's Machine for Chopping Bark and Fleshing Hides.—Fig. 3. General plan of the mill.

Fig. 4. Longitudinal section, showing the elevation of a part of the machinery.

Fig. 5. Section across part of the mill.

A (Fig. 3). Part of an undershot wheel moving the machinery. B. Shaft of the wheel, giving motion to the bevelled cog-wheel C. Another wheel F, placed upon a vertical shaft, is made to revolve by the motion of the

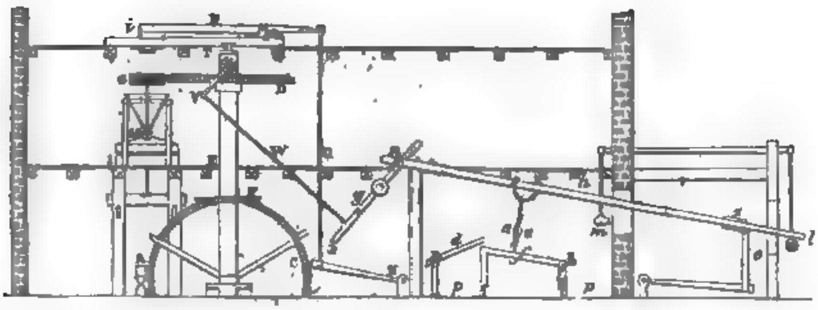
Fig. 3.



wheel C, and the cogs upon its periphery move the hammer for beating the bark, and also the choppers, in the second story of the building.

D (Fig. 4). A horizontal wheel bevelled upon its inclined surface, and toothed in an epicycloidal manner upon its

Fig. 4.



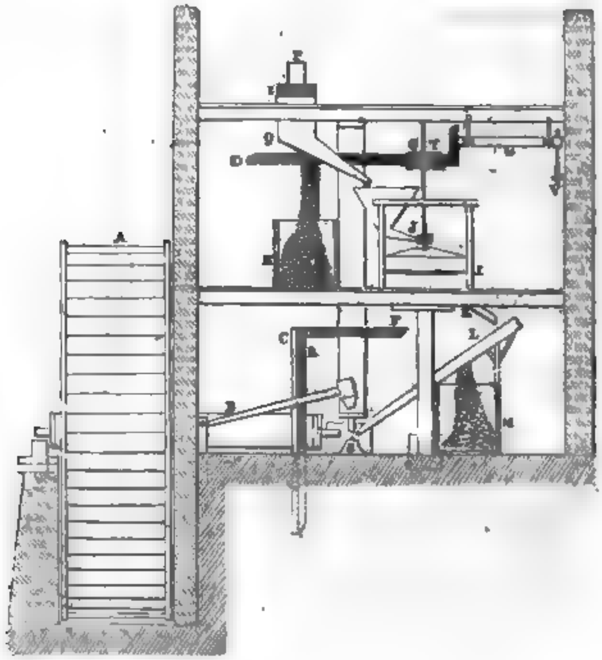
periphery. This wheel turns upon the upper part of the large horizontal shaft E, which passes through the first floor of the building. F. Cog-wheel, before referred to, gearing with the large bevelled wheel C.

G. Pinion upon the axle of the millstone I (Fig. 5).

P. The beam or handle of the cutting-blades, moving

upon a pivot, and made to rise or fall, by the motion communicated to the lever N, by the cogs upon the wheel C. When one of the cogs becomes disengaged from the end of the lever, the beam falls by its own weight, and the steel blades upon its extremity come in contact with and divide the pieces of bark placed between them and similar knives fastened to the platform at *i*. The platform *i* is made of strong timbers firmly secured by bolts to the rafters of the floor, so as to enable it to resist the shock of the falling beam. The intervals between the knife-blades are open, so that the divided pieces of bark may fall through them into a conduit Q, from which they enter the hopper of the mill H, to be conducted to the latter by a guide J (Fig. 5). The lower part of the conduit Q is provided with a wire-cloth, which

Fig. 5.



allows the powder to fall into a box K. The tan, ground in the mill, passes through the conduit O, and falls upon the sieve or bolter L, its finer particles passing through into the trough M; those which have not been sufficiently exposed to trituration being received upon the concave mortar or support S, and there reduced to a state of fine division, by the action of the round-headed hammer P, which is worked by the cogs upon the wheel C. The support is hollowed out in such a way that, at each blow of the hammer, the particles of tan acted upon are thrown out upon the side opposite to that at which they entered it.

T. Bevelled pinion, in gear with the upper surface of the wheel D, and having the end of its shaft connected with the crank V, by means of which the motion is communicated to the machinery for fleshing the skins. The crank is connected by means of the rod W with the lever X, the end of which is perforated with a number of holes, by which the bar is so adjusted that the length of the stroke may be increased or diminished.

y (Fig. 3). Shaft moving upon two axles, the sockets of which are imbedded in the opposite walls of the room; the lever *y* (Fig. 4) is connected with it near one end; and at about two-thirds of its length the cranks *n*, *n*, are attached, which give a reciprocating movement to the branches *h*, *h*, which support the fleshing-knives; so that, at each revolution of the crank V, to admit the movement of which there is an opening in the ceiling above it, the branches *h*, *h*, for fleshing the skins, are made to move in a transverse direction. In Fig. 4, the knife for fleshing is represented at *f*, fixed between two springs *a*, *a*, which render it sufficiently movable to prevent it from injuring the skins when passing across them. It is fastened by its forked

extremity to the branch *h* by a screw and nut, so that it can be unscrewed and sharpened when necessary.

z. Stop on the branch *h*, which is connected with the forked lever *e*, by means of which the knife is made to return to the end of the skin without touching its surface. The extremity of the branch *h* rolls upon the roller *l*. By lowering the handle *m*, the knife is elevated, while the skin is being placed upon or removed from the table. *b*. Table or bench upon which the skins are deposited. Each table is provided with four wheels *p*, *p*, running in the grooves *g*, *g*, which maintain it in position, and enable it to be moved at will by the levers *c*, *c*, so that each portion of skin may be in turn subjected to the action of the knife.

d. A spring, pressing upon the skin near the edge of the table, so as to prevent it from changing its position under the fleshing-knife. The iron support, or handle of the knife, is forked or divided, so as to receive the blade between its two extremities. The knife is 12 or 13 inches in length, and from 3 to 5 inches in breadth, and is adjusted in the open part of the handle, being prevented from swerving by the two springs *a*, *a*.

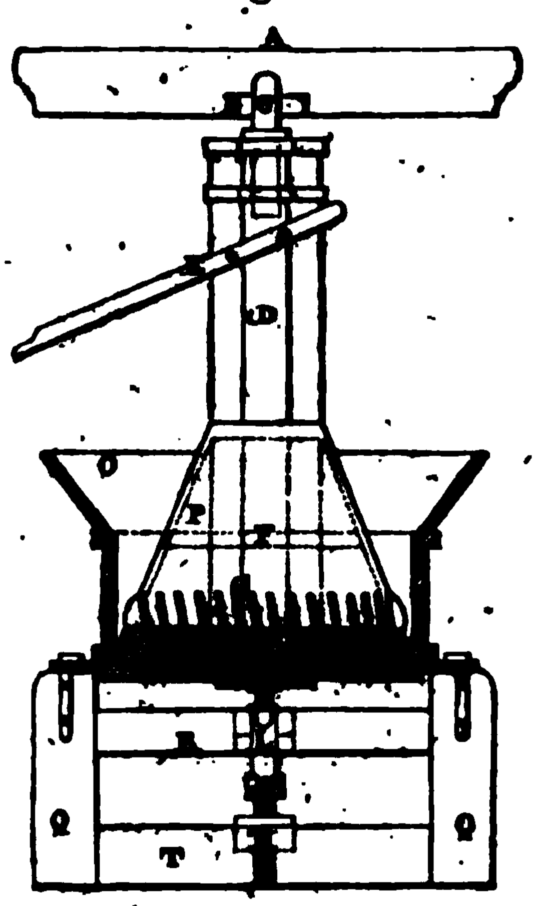
The roller *l*, with its forked lever, should be so arranged that the knife can be elevated to the proper distance from the table, by pulling the handle *m*, and hooking it upon a nail, so that the skin may be removed or placed upon the table without the necessity of ungearing the pinion T; the work being again commenced when the handle is allowed to rise.

Two benches or tables are used in this apparatus, in order that the knife may be in operation above one of them, while the workman is occupied in adjusting a fresh skin upon the other. These benches should be as wide as the largest skins, and should be made sloping at a

slight angle. The skins are kept in close contact with the surface of the support, by clamps pressing their borders down upon its edges. The pressure of the knives upon the skin is regulated by weights placed upon the beams or branches which support them. The inventor does not confine the application of this portion of the machinery to the preparation of skins for the tanning process; but also adapts it to the purposes of *tawing* and to those of the currier, by substituting hard brushes or other implements for the knives. Motion may be communicated to the machinery by the water-wheel already described, by a steam-engine, or by horse power; the labor of two horses being sufficient for the purpose.

Weldon's Mill for Grinding Oak-Bark.—Fig. 6, A. Wooden beam or cross-piece, imbedded in the walls of

Fig. 6.



the building, and perforated for the reception of the upper axle of the main shaft.

B. Iron plate or socket for the axle.

C. Axle of the shaft, the dotted lines showing its connection with the latter.

D. The shaft, which may be square, octagonal, or of other suitable form.

E. Lever giving motion to the shaft by the power of horses, harnessed to the end. When water or other power is employed, the lever is replaced by a wheel with the proper gearing.

F. Cylinder forming the lower part of the mill. It should be made of iron or brass, and may be either compact or hollow, as shown by the dotted lines in the figure.

G. Teeth, or projections for breaking and grinding the bark.

H. Lower teeth for the same purpose.

I. External iron or brass cylinder, provided with similar projections upon its inner surface, and firmly clamped and bolted to the solid framework Q, which forms the base of the machine.

K. Lower pivot or axle, firmly united with the main shaft, and turning in a socket like the upper one.

L. Iron or copper socket, fixed in the cross-beam R.

M. Regulating screw passing through the nut N, and the lower cross-beam T. By turning it, the teeth within the mill may be made to approach or recede from each other, so as to effect, at will, a coarser or finer division of the bark.

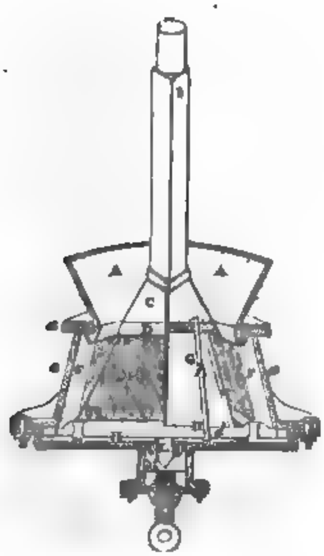
O. Hopper, made of strong wood, for receiving the materials which are to be ground.

P. Conical lining of the interior of the mill, also made of strong wood. The whole apparatus is supported upon four uprights Q, Q, firmly imbedded in the ground, and held together by the cross-beams R and T, there being two at R, meeting each other at right angles. Sieves of wire are placed between the cylinder F and the floor, which permit the passage through their interstices of the fine tan, and retain that which is too coarse.

Since its first introduction, Mr. Weldon has improved the construction of his mill, by making the teeth movable, and by other changes which we proceed to describe.

Fig. 7. Section of the improved mill.

Fig. 7.



A, A. Hopper for receiving the bark.

B. Shaft of the mill.

C. Conical casing of the cutting surfaces, for feeding the mill.

D, D. Collar for staying the teeth, with four bolts, *h*.

E. Elevation of the conical part of the mill in which the teeth are placed.

G. Section of the opposite side, showing the manner in which the teeth are adjusted.

d, *d*. One of the teeth entering the lower neck.

H, H. Lower collar in which the teeth are imbedded.

a, *a*, *a*. Outer cylinder, or cone, cast in one piece, and

showing the manner in which the movable teeth F, F, are adjusted.

I, I. Rim or collar for the attachment of the movable teeth; a part of it is seen, detached, in Fig. 8.

K, K. Support of the interior of the mill, fastened to the outer cone or cylinder by two bolts *c*, *c*.

Fig. 8.

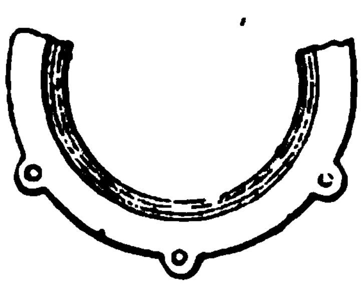
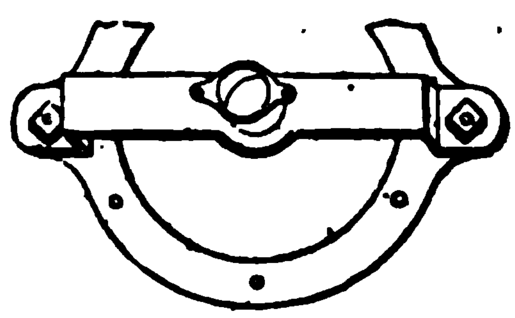


Fig. 9.



L. Lower part of the shaft, turning in a copper socket M, which rests upon the top of a screw by which the height of the inner part of the mill is regulated. Fig. 9 exhibits this part, with the collar of the rim, in which the socket and adjusting screw are placed.

Fig. 10. One of the movable teeth, detached from the exterior of the mill.

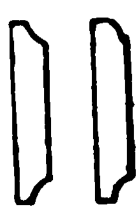
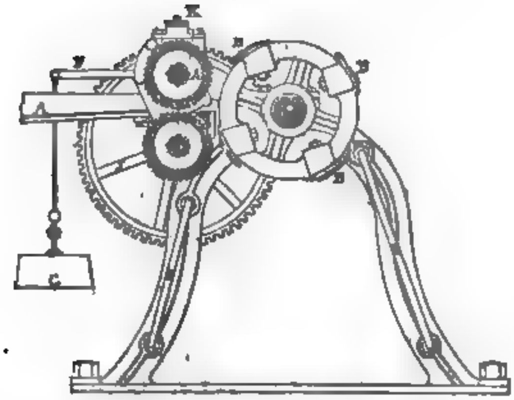
Fig. 10.  Fig. 11.

Fig. 11 is one of the teeth from the interior of the mill.

These teeth are blades of iron or composition-metal, ground to an edge, and so placed in the mill that the cutting surfaces are opposed to each other, and inclined in a direction opposite to that of the revolution of the shaft.

Farcot's Bark-Chopping Machine.—This machine consists of two feeding-cylinders A, A (Fig. 12), which convey the bark, previously spread out upon an inclined table *a*, to the edges of four large steel blades B B, which are fixed in a spiral direction upon the periphery of two parallel circles, revolving with the shaft C. The cylinders A, A, are grooved, and are moved by cog-wheels with

Fig. 12.



long teeth. The power, from whatever source, is transmitted at the same time to these wheels and to the bladed circles; *b* is a steel tie-piece which supports the pieces of bark when exposed to the action of the knives, each of the latter passing over it, like one blade of a pair of shears over the other.

The levers F suspend the weight G, the object of which is to bear upon the shaft of the cylinder A, which is constantly elevated by the passage of the bark beneath it. Guides are so placed as to direct these levers in their vertical movements, and the bark is prevented, by guards or side pieces, from falling out of the grooves, over the sides of the cylinders. The feeding cylinders are 2 feet 2 inches in circumference, and the relation of the pinion of the wheel C to the wheel J which moves it, is that of 1 to 5. About 56 feet of bark will pass between the cylinders in one minute; in the same time the wheel makes 130 revolutions, and as it is armed with 4 blades, the bark is cut into 520 pieces, each one nearly $1\frac{3}{10}$th inches in length. More than 1600 pounds of bark can be chopped in an hour with this machine, when in good

order and properly worked. Some are made, with which one man can work up daily more than 3000 pounds.

Fig. 13 is the plan in elevation.

Fig. 13.

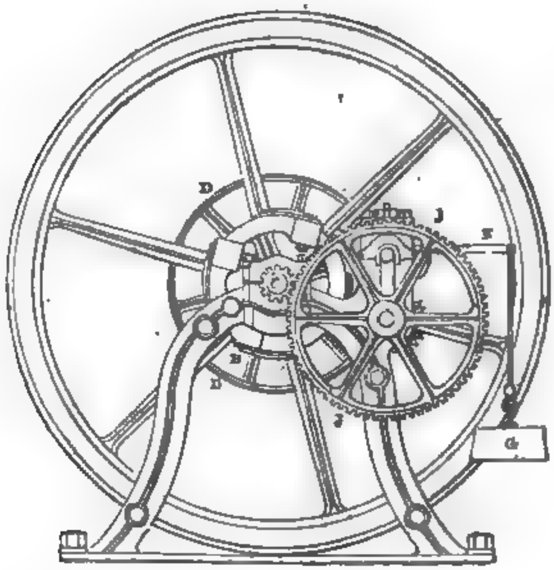


Fig. 14 is the ground plan.

Fig. 14.

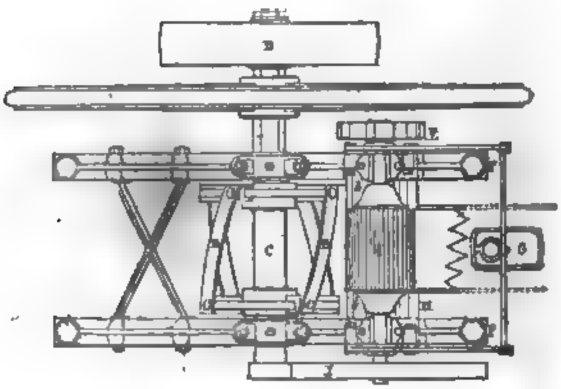


Fig. 15 shows the axle-pin of the bladed cylinder; and Fig. 16 is an end view of the latter.

Fig. 15.

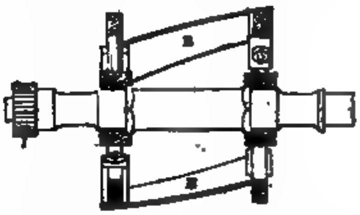


Fig. 16.

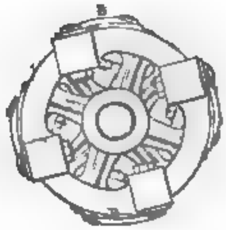
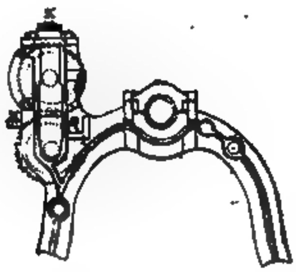


Fig. 17 represents the cast-iron frame which supports the channelled cylinders and bladed cylinder.

Fig. 17.



The bark, after being chopped as described above, is submitted to the action of the mill, which consists chiefly of two parts, the receiving and the revolving cylinder. The former is a thin, hollow cylinder, terminated below by a truncated cone, the interior of which is provided with spiral blades or teeth, some of which extend as far as the lower part of the cylinder. The base of the cone is attached by legs to the cast framework which supports the whole apparatus. Above the cylinder is a hopper, which is fed from time to time with chopped bark, the powdered tan falling down between the outer cylinder and the inner one. The outer surface of the movable

cylinder is provided with spiral teeth, similar to those of the inner one, and made of a wedge-shape, so as to present a cutting edge to the fragments of bark, which are first cut and divided by the teeth which extend towards its upper part, and are then pulverized by those upon the two conical surfaces. The cylinder is made to revolve by a shaft set in a socket which is stayed by a tie-piece. This latter is traversed by a screw, by means of which the nut may be raised or lowered, so as to increase or diminish the space between it and the receiving cylinder, and to alter at will the quality of the powder as to fineness of division. A bar passes horizontally across the interior of the inner cylinder, and is firmly attached to the shaft passing through it. The horse moving the machinery is harnessed to an arm attached to a cast-iron plate on top of the shaft. This mill is calculated to make 25 revolutions in a minute, and is capable of grinding 8600 pounds of bark in 24 hours.

Bourgeois's Bark Mill.—This machine, which was invented in 1841, and is described in volume liv. page 193, of the French reports of expired patents, is used to grind bark by means of two cylinders, one of which (Figs. 18 and 19), serving as a case for the handle, is of a cylindrical shape externally, while the other and internal one is conical; the mill revolving in a vertical instead of a horizontal direction. The outer cylinder 12 is fixed by an iron framework, 10, to the wooden supports of the mill, while the inner cylinder, 11, is movable. This cylinder and the inner surface of the outer one, are both fluted with longitudinal grooves, describing curves along their length. Each of these grooves is divided into two, at the larger end of the cylinder, and into four at the smaller end, the separation commencing at the middle. The inner cylinder can be completely

encased in the outer one, by the turning of the screws, 14, and the arrangement of grooves is intended to effect a more or less complete division of the particles of tan.

When the cylinders are closely in contact, the bark is first exposed to the action of the larger grooves, which are deeper than the others, and then becomes engaged in the second and third divisions, by means of which it is reduced to a finer powder. If it be desired to produce a less complete trituration, the screws, 14, are loosened, and the spring, 13, then presses the inner cylinder from its place, in such a manner that the bark is only acted upon by the larger grooves.

Fig. 18.

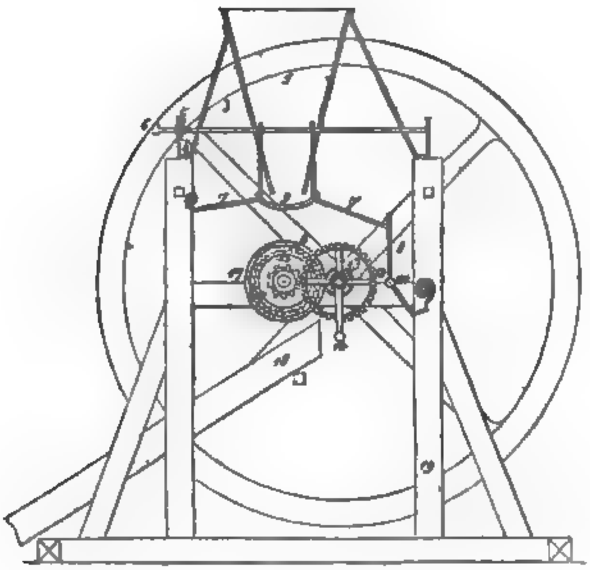


Fig. 18. 1. Hopper of the mill.
2. Spout of the hopper.
3. Regulator of the spout.
4, 5. Escapement wheel.
6. Handle of the regulator.

7. *bis*, strap attached to the spout.
8, 9, 10. The spout and its motive appliances—spring and strap.
11. Handle for turning the machine.
12. Arm of the lever turning the spout.
13. Trundle.
14. Large cog-wheel.
15. Small cog-wheel.
16. Internal conical cylinder.
17. External conical cylinder.
18. Trough for receiving the tan.
19. Wooden framework.

Fig. 19.

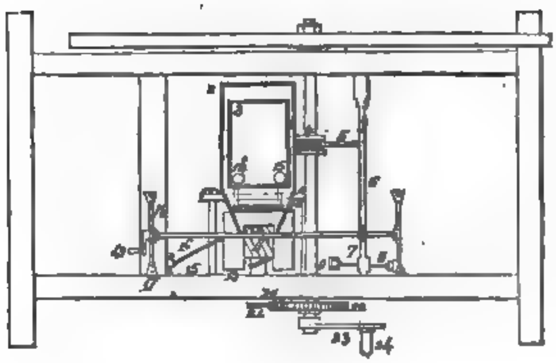
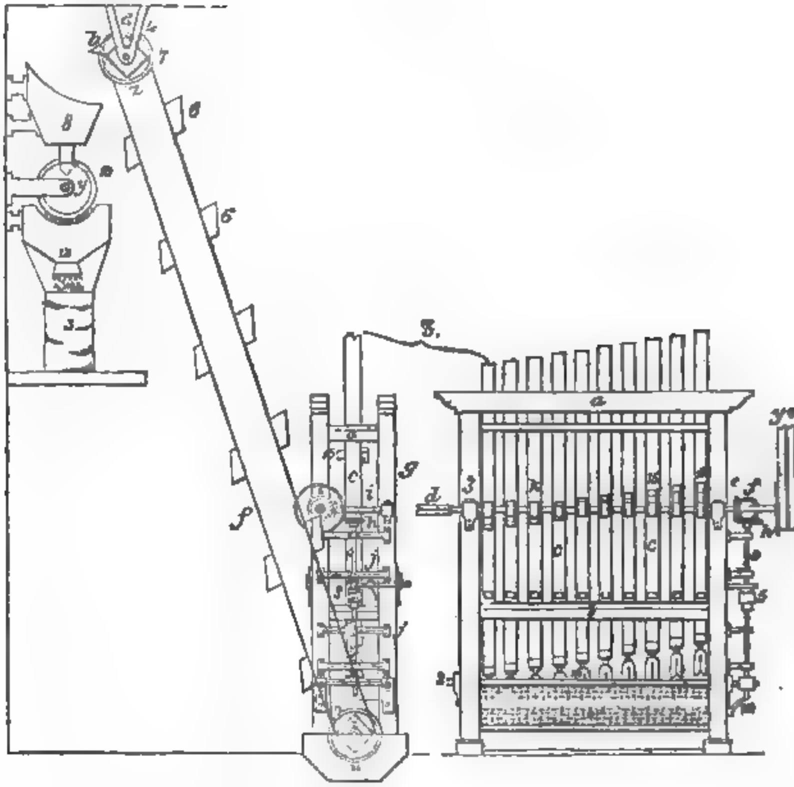


Fig. 19. 1. Fly-wheel.
2. Spout under the hopper.
3. Hopper.
4. Trundle.
5. Lever arm for turning the spout.
6. Axle of the lever.
7, 8, 9. The motor and regulating appliances of the spout.
10. Framework supporting the cylinders.

11. Internal cylinder, with grooves cut as before described.
12. External cylinder channelled like the inner one.
13. Spring, regulating the inner cylinder.
14, 15. Compressing screws, acting upon this cylinder.
16. Spring acting upon the spout.
17. Escapement wheel.
18. Regulator of the spout.
19. Handle of the regulator.
20. Axis of the cylinders.
21. Small canting-wheel.
22. Large canting-wheel.
23. Axle of the trundle and fly-wheel.
24. Crank.
25. Wooden framework.

Lespinasse's Bark Mill.—This apparatus was invented in 1843, and is described in vol. lix. at page 428, of the French expired patent reports. Fig. 20, *d*, iron shaft turned by the pinion, moved by the power, and supporting and moving the stops of the rammers or stampers, *c*, shown at *k* in the figure. This shaft acts upon the conical pinion, *e*, and through it upon the similar vertical pinion, *f*, which communicates the motion to a small horizontal shaft, *l*, upon which there is another similar pinion, *g*, by means of which the horizontal pinion, *h*, is made to revolve. This latter transmits the motion to a vertical shaft, *o*, and gives a reciprocating movement by means of the pinions, *e*, *f*, *g*, *h*, to the curb, *m*, placed horizontally between the sides of the rammer, *n*. This curb, by its constant movement to and fro, forces the portions of bark divided by the knives of

Fig. 20.



the rammer, *n*, through the holes, *x*, made of different dimensions in the sides of the apparatus, into the conduit, *t*, and the trough, *u*. Above this latter, is a drum, *z*, connected by a strap, 5, to which the buckets, 6, are adapted, with a similar drum, *z'*. These two drums are made to revolve by a strap, *v*, moving at one end over a drum, 7, placed at the extremity of the shaft, *d*, and at the other, upon another drum, 7', above the preceding, and which is connected with that supporting the strap, 5, with the buckets, so that these latter, in their revolution, become filled with the tan in the trough, *u*, and empty it into the wooden hopper, 8.

In the bottom of this hopper is an opening connected with a wooden conduit, leading to a sieve, which is divided lengthwise into three parts, each of which is perforated with holes of different sizes. This sieve is moved by an arrangement below it, which is connected with the strap, *y*.

12. Troughs to receive the residue from the sieve, 10.

13. Bags in which the residue of tan is placed.

14. Cords keeping the bags in place under the mouth of the trough.

15. Lever of the rammers.

i. Arched framework for keeping the shaft, *o*, in a vertical position. This shaft is divided into two parts, connected by means of a coupling, *s*, which may be separated at will, by means of an iron tool, *j*, attached to the framework of the machine.

1. Small stops for regulating the movement of the rammers.

2. Cushions through which the arms of the curb pass.

3. Framework supporting the horizontal shaft, *l*.

4. Supports of the drums, over which the buckets revolve.

a. Wooden framework of the machine.

b. Beam supporting the pegs for keeping the rammers at rest.

c. Rammers with knives at their lower ends.

16. Cross-bars made to revolve by the shaft, *o*, so as to strike against the wooden box, *t*, and hasten the descent of the tan into the trough.

Wiltse's Mill.—This machine, known as the "Catskill Mill," and extensively used in the tanneries of the United States, is made by A. and B. Wiltse, intelligent and enterprising machinists of Catskill, Green Co., New York. It is constructed upon the principle of the shears, the

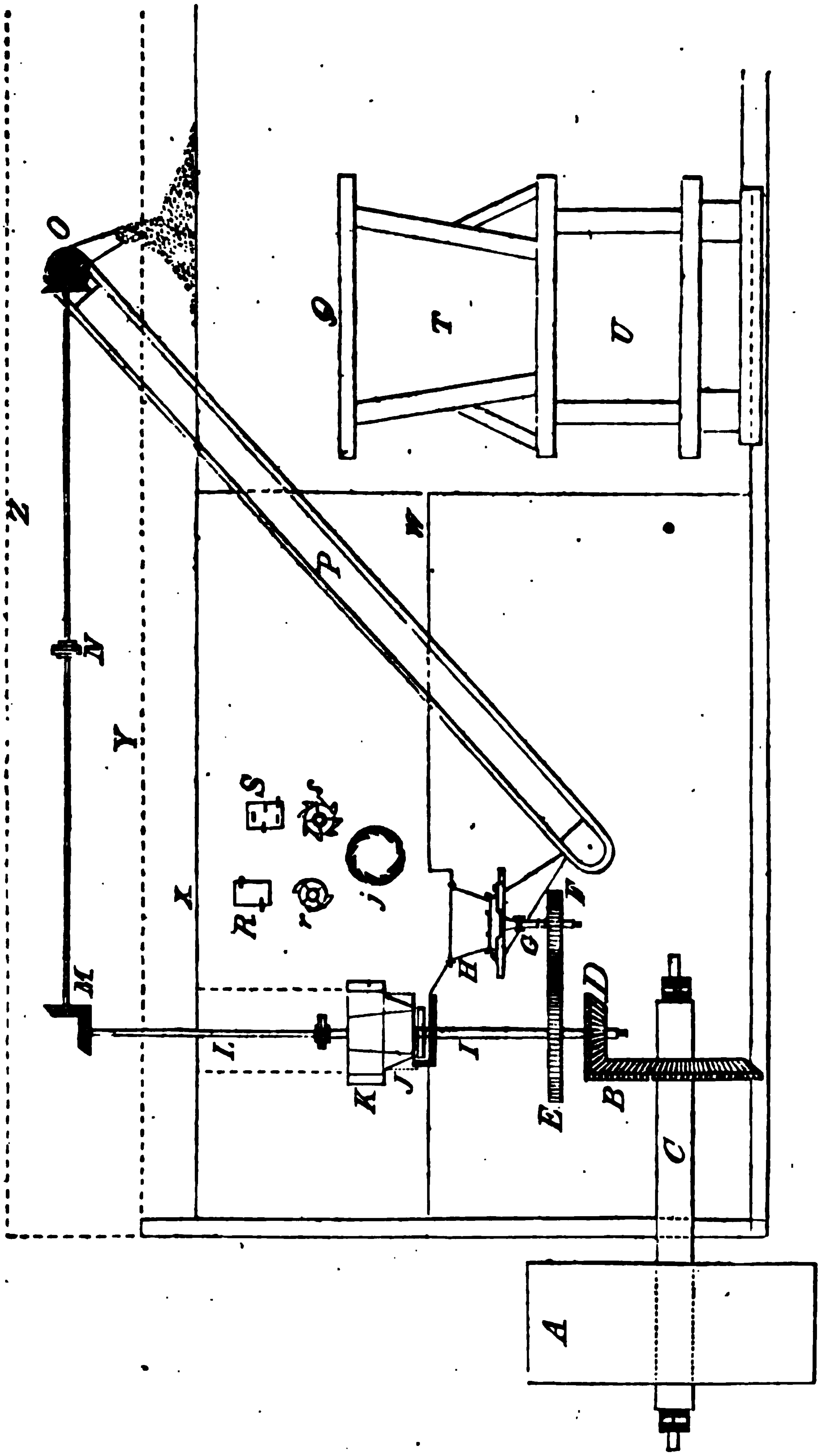
teeth being arranged with their edges at an angle, and thrown forward, so that the bark may be driven in and ground rapidly, and passed through without interruption. Fig. 21 represents the machine, which may be driven by

Fig. 21.

water or steampower, and so arranged as to receive the bark from the breaker and to deliver it ground in the leach-vats. To give a better idea of the manner in which it works, we give, on page 133, a plan showing the relative positions of the breaker, bark-mill, and leach-vat. Fig. 22 is drawn upon a scale of a quarter of an inch to one foot.

A is the water-wheel, and *C* its shaft; *B* is the bevel-wheel which drives the bevel pinion *D* on the foot of the main upright *I*, which also carries a spur-wheel *E*, and drives a spur-pinion *F* on the shaft *G*. The top of the mill sets ten inches below the second floor, in order to admit the bark running from the cracker *J*, *K*, above. This latter consists of a cast-iron curb or hoop *J*, of 18 inches diameter, and ten inches depth, with three jagged teeth, as shown in end and interior views at *j*. The top of the cracker *K* is made of two blocks of wood, firmly secured to two uprights, represented by the dotted lines,

Fig. 22.



by means of bolts passing through the portion which laps them. The two blocks of *K* have openings in their centres, of 18 inches diameter at the base, and 24 inches at the top, to correspond with the size of the curb on which they rest. About 7½ inches from the bottom are four strong wrought-iron teeth, so inserted as to be in the centre between the teeth on *R*, *r*. The latter are secured to the shaft *I*, inside of *K*, as indicated by dotted lines; and *S*, *s*, is also similarly placed on shaft *L*, inside of *J*, *j*. A second length of the iron shaft *L*, drives *N* by the aid of the bevel-wheels *M* and *N*, which are so geared as to drive, in turn, the pulley-shaft *O* at the head of the elevators. The elevators take the bark from the mill and deliver it into a bark-room or loft above the leach-tubs *Q*, whence it may be drawn, as wanted, through a trap.

The drawing shows two leach-tubs, but the number may be increased according to the demands of the tannery.

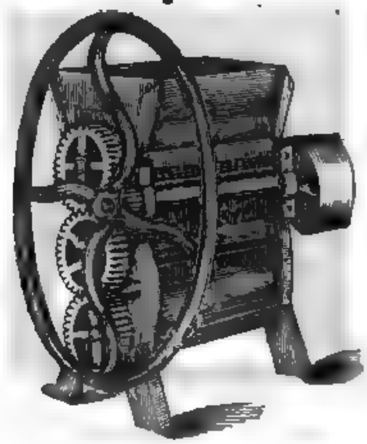
The above mill possesses superior advantages, as it does its work effectually and with despatch. It cuts the fibre of the bark short, without flouring it, and passes it, even when wet, without becoming clogged. It is designed, also, for purposes of economy and durability, as well as of convenience; the arrangements of the parts being such, that when any of them, by wear, require renewal, they may be easily removed and replaced by others.

When worked to its utmost capacity, it will grind from one to two cords of bark per hour, and must be driven at the rate of 150 revolutions per minute by a ten-horse engine. At 100 revolutions it is less efficient. With one horse power, it may be driven at the rate of five revolutions per minute, and will then grind one cord in from one to three hours. The cracker should move at the rate of 30 to 40 revolutions per minute.

If steam is used as the propelling force, the waste steam may be economized and applied to heating the leach-vats. A convenient arrangement for this purpose is constructed by the Messrs. Wiltse.

Birely's Mill.—Another ingenious grinding apparatus is that invented by Mr. Valentine Birely, of Frederick County, Maryland. It reduces the bark to shreds and strings, forms favorable to the entire extraction of its soluble matter by the liquor of the vats. Fig. 23 pre-

Fig. 23.



sents a perspective view, and Fig. 24 a vertical cross-section of the machine.

The framework is of cast-iron, with apertures at the sides for the journals of three cylinders, and flanges and ribs for securing a wooden hopper. These cylinders are of different diameters, and are propelled by means of a drum and cogs at the ends. Being denticulated on their surfaces, and revolving in concaves similarly studded with teeth, and arranged in alternate order to correspond with the reversed movements of the cylinders, the bark

Fig. 24.

is reduced with great readiness, and the mill runs without obstruction. The coarse teeth of the first cylinder break it down preparatory to its passage through the next, and finally the last cylinder, which delivers it ground to the required degree of fineness.

These mills are made of three sizes, and the largest, driven by a ten-horse power engine at the rate of 80 revolutions per minute, will turn out twenty-five cords of bark every twelve hours.

The lengths of the cylinders in the three different sizes are, respectively, 21, 24, and 33 inches; and the smaller ones grind in proportion to the power applied.

CHAPTER XI.

THE STRUCTURE AND CONSTITUTION OF SKIN.

The tegumentary membranes encase the whole surface of the body, and are prolonged into its interior, so as to line its various cavities and passages. These internal prolongations, however, are called mucous membranes, and differ in character from the external integument or *skin*, of which alone it is our intention to treat.

The skin, or dermoid tissue, presents the same form and extent as the body which it covers, and follows all its inequalities of surface. It is corrugated in many places into wrinkles or plaits, on account of its not being susceptible of the same degree of expansion and contraction as the more mobile tissues which it envelops; the largest wrinkles being produced by the contractions of muscles and the flexion of joints. The outer surface of the skin is comparatively smooth and uniform; is covered more or less with the secretions from bulbs or follicles which are called hair, or wool, and also presents numerous papillary projections and minute depressions, which latter are the orifices of the perspiratory and sebaceous ducts, proceeding from glands or follicles, in which the secretions destined to moisten the surface are eliminated. The inner surface of the skin is connected with and tied to the subjacent parts by an areolar or cellular tissue, which binds them together more or less tightly, in proportion

to the less or greater freedom of motion of which the skin is capable. This cellular tissue contains in its cavities adipose or fatty matter, which confers the requisite firmness and solidity upon the parts, and protects the structures beneath the skin from the injurious effects of undue pressure. The cellular tissue is also penetrated in various directions by the bloodvessels and nerves distributed upon the skin, and in some instances, gives passage to, and supports cutaneous muscles, which are inserted directly into its base.

The skin is a compound membrane, and though actually consisting of only two distinct tissues, may be conveniently divided, as has been the habit of most anatomists, into three layers, viz.; corium, rete mucosum, and cuticle.

The Corium.—The corium, *cutis vera*, or true skin, forms the basis or principal part of the skin, being much thicker than the other layers, and giving them support. It consists of a cellulo-fibrous tissue, which upon maceration, appears to be made up of dense filaments, crossing each other in various directions, so as to inclose spaces or areolæ. These are of considerable size at the inner surface of the membrane, where granules of fat, bloodvessels, and nerves project into them, but diminish towards the outer surface, where the structure becomes dense and uniform. This latter is not perfectly smooth, but is studded with minute prominences called *papillæ*, which project in many places so much as to be evident to the sight and touch, and which have been supposed by some anatomists to constitute a separate layer, called *textus papillaris*. The tactile sensibility is believed to depend upon its degree of development.

The corium is generally white, owing any changes of color to the greater or less amount of blood present in it.

It is supple and elastic. When dried, it presents the appearance and properties of horn, and is converted into gelatine by boiling in water.

The Rete Mucosum.—The next layer of the skin, the *rete mucosum*, is a soft gelatinous tissue, spread out upon the surface of the corium, between it and the cuticle. The composition of this stratum has given rise to much discussion. It appears to be a semi-fluid deposit or secretion, rather than an organized substance, although Gautier and other anatomists have not merely admitted its existence as a separate element of the skin, but have resolved it into four distinct layers, placed one over the other. In white skins, it is without color, and so thin that it is difficult even to demonstrate it. It is the seat of the *pigmentum*, or coloring matter, which darkens the skins of the colored races of men and of some animals, and in them is very evident. This coloring material is disseminated throughout its substance, in the form of minute globules, which are supposed to consist chiefly of carbon. The rete mucosum is now believed to consist of granules, forming the deepest and most recently deposited portion of the cuticle, not compressed into scales or laminæ, like the more superficial particles.

The Cuticle.—The cuticle, epidermis, or scarf-skin, is the outer or superficial layer of the integument, and is connected firmly with the subjacent tissues by numerous delicate filaments, and by the ducts and hairs to which it gives passage; but it can be readily separated from them by decoction or maceration. It is usually a thin, varnish-like covering to the subjacent tissues, but its thickness varies with the amount of pressure to which it is subjected. It is now acknowledged to consist of the same granules which constitute the substance of the rete mucosum, compressed and hardened into minute horny

scales, which are constantly being shed; their places being supplied by new particles from the moist and more recently deposited granules below them. The cuticular surface descends into, and lines the follicles which secrete the hair, and the ducts for the discharge of the perspiratory and lubricating fluids.

COMPOSITION OF THE SKIN.

Having treated of the structure of the skin, we proceed naturally to consider its composition. The skin of animals consists of fibrine, gelatine, and small portions of albumen and fatty matter. The first two form, as it were, the basis or network of the whole tissue, a portion of which, if boiled with water, yields its gelatine, while the fibrine remains. The *epidermis* of the skin does not combine with tannin. The properties of these substances which play such an important part in tanning, are as follows:—

Fibrine.—This is one of the immediate and most abundant principles in animals. It exists in the chyle and blood, and is the basis of muscle. It may be prepared by *whipping* blood with a bunch of twigs, and washing the coagulum of fibrous filaments in fresh water until it loses color. It is a white, tasteless, inodorous solid, heavier than water, soft, slightly elastic, and without action upon litmus. Fibrine loses four-fifths of its weight by drying, and becomes yellowish, hard, and brittle, but regains much of its original appearance by soaking in water. It is insoluble in cold water, and hardens without dissolving in hot water, but is modified in composition and properties. When left in contact with cold water, for several days, decomposition accompanied by a cheesy odor, ensues.

With weak caustic lyes of soda and potassa, it first gelatinizes and then forms yellow solutions at from 120° to 130° F. If the lyes are concentrated, ammonia is given off during the heating. Caustic ammonia is less feeble in its action than the fixed alkalies.

These alkaline solutions are precipitated by several metallic salts, with the oxides of which it forms imputrescible compounds; for example, with the chloride of mercury and sulphates of copper and iron. The same reactions ensue when fibrine is digested in solutions of metallic salts.

Dilute sulphuric acid shrivels fresh fibrine, and ultimately combines with it, forming a jelly soluble in water. Dry fibrine is changed by strong acid into a yellow, gelatinous mass, without being dissolved. In large quantities, the reaction evolves heat, develops sulphurous acid, and blackens the mass.

Nitric acid generates nitrogen and new derivatives of fibrine. Hydrochloric acid forms a blue solution, from which water precipitates white hydrochlorate of fibrine. If the acid be very dilute, the fibrine swells and becomes gelatinous. Concentrated acetic acid rapidly gelatinizes fibrine, and renders it soluble in hot water.

Tannin precipitates it from both its acid and alkaline solutions, and when fresh fibrine is immersed in solution of tannin, it becomes, on drying, tough, hard, and imputrescible.

Its ultimate percentage composition, according to Dumas and Cahours, is:—

Carbon	52.78
Hydrogen	6.96
Oxygen, &c. (sulphur and phosphorus)	23.48
Nitrogen	16.78
	100.00

Gelatine.—$C_{13}H_{10}O_5N_2$. This is an immediate animal principle, and derives its name from the fact of its hot aqueous solution forming a transparent, tremulous jelly on cooling. It is found in bones, horns, muscles, tendons, and ligaments, although it does not pre-exist as such in these tissues; and it may be prepared by the prolonged action of boiling water upon them.

Isinglass, size, and glue are different kinds of gelatine, varying in physical properties according to their source. The gelatine from cartilage is named *chondrine*, and possesses properties different from those of true gelatine or *glutin*, as it is termed by way of distinction.

Glutin is the principal component of glue, and is prepared in a pure state, by soaking the latter repeatedly in quantities of fresh water, until all soluble matters are removed, and by then boiling and straining the residue.

Gelatine is colorless, or yellowish, transparent, tasteless, and inodorous. It does not lose its transparency by drying, but becomes hard, brittle, and horny. It softens and swells, and very slightly dissolves in cold water, but is very soluble in hot water, from which alcohol precipitates it. Repeated and successive boilings and coolings of its aqueous solution impair its gelatinizing property.

By immersion in alcohol, it loses water and shrinks. It is soluble in all the dilute acids and in caustic alkaline lyes, and therefore its aqueous solution is not disturbed by either. Chlorine gas, however, produces in it white, elastic flocculæ. Gelatine is not altered by boiling with hydrated lime.

Subacetate of lead precipitates aqueous solutions of gelatine, as also do the sulphate of platinum, nitrates of mercury, protochloride of tin, and (by boiling) neutral persulphate of iron.

Alcohol and ether are without action upon dry gelatine.

The characteristic property of gelatine is that of combining with tannin, and forming a grayish, glutinous, elastic compound, which, upon drying, becomes unalterable and imputrescible in water, and forms the basis of *leather*.

The mutual affinity of these two substances is so strong that the latter will precipitate the former from a solution containing so little as one part in 5000 parts of water. Gelatine, however, does not exist exactly as such in skins, and therefore leather (a compound of gelatinous tissue and tannin), though very analogous to, is not strictly identical with this elastic precipitate of *tanno-gelatine*, which is slightly soluble in water and becomes brittle on drying.

Mulder, who has examined the subject, says that there are two definite compounds of tannin with gelatine. For example, when a solution of pure gelatine is mixed with one containing a great excess of tannin, the resulting precipitate, which is white and curdy, and becomes reddish-brown, hard and brittle on drying, consists of one equivalent of tannic acid and one of gelatine. This is the neutral compound. If, however, the tannin be not added in excess, then the compound will contain three equivalents of gelatine and two of tannic acid. The precipitate of gelatine by infusion of oak bark is composed, according to Davy, of 54 parts of gelatine and 46 of tannin; or 100 of the former and 85.2 of the latter. Schiebel found that 100 parts of gelatine in solution, when precipitated by a great excess of infusion of oak bark, made with 1 part of bark to 9 of water, combines with 118.5 parts of tannin. If, however, the infusion be weak, and not added in sufficient quantity to

precipitate the whole of the gelatine, the compound which is thrown down and slowly subsides, consists of 100 gelatine, and only 59.25 of tannin.

The ultimate composition of gelatine is

	Löwig.	Mulder.
Carbon	50.00	50.04
Hydrogen	6.41	6.47
Oxygen	25.64	25.13
Nitrogen	17.95	18.36
	100.00	100.00

Albumen is a component of nearly all the animal solids; and when free from foreign matters, is soluble in water. This solution coagulates at 160° F.; but the coagulum may be re-dissolved by heating it with water in a digester to 400° F.

As precipitated from the aqueous solution of white of eggs, or of the serum of blood, it is pure and soluble in acetic acid, very weak alkalies, and in soluble salts with alkaline bases. Its solution in nitrate of potassa is coagulable by boiling.

Albuminous solutions are precipitated by sulphuric acid. Hydrochloric acid produces a coagulum soluble in water, and in strong hydrochloric acid by heat. Nitric acid throws down a flocculent precipitate, soluble in alkalies, even from very dilute solutions. Acetic acid gives no precipitate, even by heat, unless both acid and solution are concentrated. In that case, a gelatinous compound, soluble in excess of acid, and in water, is formed.

Albumen is soluble in alkalies. Waters of lime, baryta, and strontia, have no reaction upon the aqueous solution of albumen; but with the alkaline earths themselves it

forms insoluble compounds. Earthy and metallic salts throw down double compounds, one with acid and another with metallic oxide, the latter of which is wholly insoluble, while the former is not entirely so.

Tannin precipitates albuminous solutions, but the resulting compound is not softened by heat like the tanno-gelatine.

According to Weinholt, fresh skin, freed on its internal side from fat and cellular tissue, and on its grain side from the epidermis and mucous membrane, contains 42 per cent. of solid matter, and 58 of water. The solid matter consists of

Cellular tissue	32.
Albumen	1.50
Extractive matter (soluble in water and in alcohol)	1.00
Extractive (soluble in water, but insoluble in alcohol)	7.50
	42.00

CHAPTER XII.

OF THE DIFFERENT KINDS OF SKINS SUITABLE FOR TANNING.

SKINS are technically classified: 1. As *hides*, which comprise the skins of oxen, horses, cows, bulls, and buffaloes, and are employed for thick sole leather. 2. As *kips*, consisting of the skins of the younger growth of the above animals, and 3. As *skins*, of small animals such as dogs, sheep, goats, seals, &c., which are used for upper, thin, and fancy leathers.

The quality of leather depends not only upon the nature of the skin and the mode of tanning it, but upon the results of numerous minor details which require especial care and attention.

Hides or skins retain their original name until after they have been subjected to treatment in the lime-pit. When placed in the tan-vats, they become *leather*.

Hides are sent to market either *fresh* from the slaughter-house; or *dried*, or *salted;* or both *dried and salted.*

Besides the skins furnished from the slaughter-houses, our tanners work large supplies imported from Buenos Ayres, Brazil, Texas, and California. They also obtain small lots of stock from the Antilles, west coast of Africa, and from other parts of the world. Those of Russia are larger and stronger than either the French or our own; but we receive very few of them in their raw state, nearly all being imported already tanned into leather.

Some supplies are likewise drawn from the Levant, and from the Spanish possessions in America. Sheep-skins are imported from the Cape of Good Hope, and Buenos Ayres; goat-skins from Barbary; lamb and kid skins from Italy; and seal-skins from Newfoundland. Kips come from Buenos Ayres, St. Petersburg, and the East Indies. The supply of domestic hides is comparatively limited. Swiss hides are of excellent quality, but we get few or none of them in this country.

Skins from large cattle are best, provided they are not thin and flabby, for such will only make inferior leather. Those from cattle slaughtered in the colder months, give, it is said, five per cent. more leather than hides taken in summer. The nature of the food and state of the animal's health, also, have an influence upon the quality of the hide.

For the production of 40 pounds of leather, there are required, as the average, 30 pounds of dry hide, 60 pounds of salted hide, or 74 pounds of market hide.

Those from Brazil and Buenos Ayres, whence our stock of foreign hides is principally drawn, are of sufficient goodness for tanning if they have not undergone any injury during the importation. Sometimes, however, the process by which they have been dried, renders them brittle and only serviceable for conversion into glue.

The Buenos Ayres hides are taken from the wild cattle which are run down by hunters. After being removed from the carcass, they are spread upon the ground with the flesh side uppermost, and left exposed to sun and air until dry. To prevent shrinking and wrinkling, the hides are kept stretched, by means of wooden pegs driven through the corners into the earth.

Brazilian hides are nearly all slaughtered in the ordinary manner.

It would be greatly to the interest of the tanner, and would save him much annoyance, if all hides were imported in a *green* state, that is, merely salted; for when dry, it is very difficult, even for the most experienced, to detect many defects which would impair the quality of the leather into which it is to be converted.

The large ox-hides are the ones chiefly used for conversion into sole leather; for cow-skins, though of denser structure, are rather too thin for this purpose, and are, therefore, reserved for making saddler's leather. This latter remark, however, applies only to the hides of old cows which have repeatedly calved. These are weak and distended. The hides of *heifers*, on the contrary, are considered equal, if not superior to those of oxen.

Bull-hides, on the other hand, are the least esteemed of all, being thinner, and more flabby than those of either oxen or cows.

A well-fed, moderately-worked ox, when slaughtered in a healthy condition, will naturally yield a hide of normal quality. But if sick, lean, or deficient in hair at the time of being killed, then the hide is not adapted for making good leather. Should the animal die suddenly by accident, without any diseased condition, the quality of the hide is not thereby impaired. The hides from unhealthy bullocks or horses, present a decided difference from those of the same animals slaughtered in a sound condition. This difference is not distinguishable by any very evident characters, though it seldom escapes the sagacity of an experienced tanner.

There are no definite rules for estimating the quality of hides. If a skin is free from the defects already mentioned, and has sufficient strength and thickness, with body and firmness, then it may be presumed that it will tan well, and make good leather. A skin presenting the

opposite characters, that is flabby, soft, thin, *weak*, and will not bear handling, should not be considered reliable. These signs, however, are not always unerring, for anomalous cases frequently occur. Indeed, it may sometimes happen that the hides from a diseased carcass, differing in appearance from the rest, will produce excellent leather.

As the skins could not be kept any length of time in a fresh state without being injured by putrefaction; and as it would be impossible to transfer them as soon as slaughtered to the tan-vats, they are preserved unaltered by salting or drying them. The country butchers stretch them out in drying-lofts or in the shade; while those in the city generally salt them. Steger, a Hungarian tanner, recommends the application with a brush of a coating of pyroligneous acid, which he says will not only preserve the hides, but even arrest incipient putrefaction without impairing their good quality in other respects.

The skins from the slaughter-houses in cities or towns, and their environs, are generally sold to the tanners soon after being stripped from the carcass, and in a green state. Although it is the usual custom to salt hides, it is never done by the butcher when the transfer to the tannery is to be immediate. Those butchers who live at a distance, have necessarily to salt, or else to dry them, so as to preserve them in a marketable condition, during their storage and transportation.

In the sale of unsalted green hides, there are certain reprehensible frauds which it is difficult to provide against. For instance, not only are the horns, ears, and other less valuable parts left upon the skin, but the butcher, in order still further to increase its weight, beds the animal, before slaughtering it, in filth and mire, and

then, after skinning it, trails the hide upon the dusty ground.

Domestic, or Slaughter Hides.—Heavy hides are converted into sole, belt, and harness leather. The very largest are selected for carriage-tops. The smaller and lighter ones are used for "skirting" and for enamelling. When intended for ladies' shoes, or bridle-leather, they undergo a bleaching process, in the currier's shop, termed "fair finish." The hides from northern latitudes are preferable to those from the South. Hides from the extreme South are particularly objectionable for conversion into leather. Those from California, when free from the defects caused by unskilful skinning, are of good quality.

Spanish, or South American Hides.—The dry hides are generally converted into sole leather, and occasionally into belt leather. Those imported in the green and salt states, are sometimes made into upper leather, which is of fair quality.

African hides from the west coast make good uppers; but are largely used in their raw state for covering hair trunks. Madagascar hides are good when perfect, which is rarely the case, as they are liable to injury during curing or transit.

Calf-skins.—The hides of the neat yearlings go into calf-skins. Of these latter, there are "Patna" kips and common calf for bookbinders. The Patna kips are very inferior, and though frequently sold as "Calcutta" kips, have the distinctive property of greater weight. A few kips come from South America, and some from England and Ireland. The supplies of the tanneries are mostly domestic skins.

Calf-skins are valued in proportion to their strength

and size. The French tanners, who are renowned for the excellence of their calf leather, use the skins taken from animals of five or six months of age. Those from calves of less than two months' age are very inferior, and only suitable for the manufacture of parchment.

Buffalo Hides.—Those from our plains are prepared with the hair on, by the American Indians, as robes. The so-called buffalo hides, imported from the East Indies, are tanned into sole leather of inferior quality. Prepared in a particular manner, with oil, they become "buff belt" leather. An inferior "buff belt" leather is also made from cow-hides.

Horse Hides are tanned for uppers and make good leather. They are also tanned for thongs for sewing belts, &c., and are the best material for that purpose.

Goat-skins, when tanned and curried, are used for the uppers of ladies' shoes. Tanned in a particular manner, and dyed with fancy colors, they constitute Morocco or Turkey leather. By tawing, they are converted into Chamois, or wash leather, which is also made from deer-skins. The best goat-skins come from Mexico, and are known in commerce as "Tampico" skins. The sound skins from the Cape of Good Hope are very large and far superior to those from Madras and the Cape de Verds.

Sheep-skins make a spongy weak leather, used principally for linings and trunk trimmings. Saddlers and bookbinders also use them largely. When curried and blackened, they may serve as inferior upper leather for children's shoes. Sheep-skins are also converted into parchment and vellum.

Hog-skins are tanned exclusively for saddle seats.

Dog-skins make good leather. They are also tawed for glovers' use.

Beaver and buck skins are mostly tawed or oiled for glovers' use.

Ass or mule skins serve to make *shagreen* or *sagri* for the manufacture of scabbards.

Seal-skins are converted into materials for caps and fur clothing. Many are also tanned into upper leather of inferior quality. The large skins come from the Falkland Islands, and the small ones from Newfoundland.

White porpoise-skins.—Porpoise leather, properly tanned, is said to be strong, soft, and of beautiful finish. It is made in Canada.

Leather is differently designated in commerce, according to the mode in which it is curried or dressed, and sometimes the use for which it is intended. For example, "harness" leather is blackened in the grain; "russet" is "fair finished" leather; wax leather is blackened in the flesh; and "buff" is that with the grain divided by careful shaving and blackened on the grain side.

MODE OF SALTING HIDES.

Delalande's method, which is that generally adopted, consists in laying open the hides upon the ground, and sprinkling the flesh sides with salt, more liberally at the edges and on the spinal portions, than on other parts. They are then folded, or doubled lengthwise, down the centre. The remaining folds are made over each other, commencing with the shanks, then the peak of the belly upon the back, afterwards the head upon the tail part, and tail part upon the head, and lastly, by doubling the whole with a final fold, and forming a square of one or two feet. This being done, they are then piled three and three together, and left until the salt has dissolved and penetrated their tissue, which generally requires

three or four days. Thus prepared, they are sent to market.

Skins may be dried, even after having been salted, by stretching them upon poles, with the flesh sides uppermost, and exposing them to dry air in a shady plaee.

Ten pounds of salt in summer, and somewhat less in winter, are requisite for each skin of ordinary size.

CHAPTER XIII.

PRELIMINARY TREATMENT OF SKINS.

In order to prepare the raw hides for the action of the tanning agent, it is necessary to subject them to several preliminary operations. These consist in *soaking*, or *washing* in water, and *fulling*, or *beating*, in order to soften them, and to remove the adhering blood and filth; *swelling*, or *raising*, to "plump" the hide; *depilating*, to separate the hair; *fleshing*, or *working on the beam*, to remove the loose flesh, fatty matter, &c., from the flesh side, and the epidermis and hair from the grain side; and *rinsing*.

These leading manipulations are modified to suit certain kinds of skins, as will be directed hereafter; and some undergo an additional treatment, termed "*bating*," to remove lime, and otherwise promote the thorough union of the tan material and the gelatinous structure.

WASHING AND SOAKING.

This is the first operation that the skins must undergo, and it is therefore a great convenience to have the tannery located upon, or near to a stream or running spring, with an abundance of water. The skins are taken in a *green*, *dry*, or *salted* state.

The *green* hides are those from recently slaughtered

animals. They are placed in water, and left to soak for half a day, or longer, if necessary, for the removal of blood and adhering dirt. If the skins are not very dirty, an hour is sufficient. They are to be well rinsed before taking them out of soak. If it should be necessary to soak them for a longer time, they must be handled or moved about at frequent intervals.

If the water is abundant and the current rapid, time and trouble will be saved by planting stakes, or a kind of rack across the stream, and so fastening the skins thereto that the friction of the water may loosen the dirt and carry it off. Care should be taken to suspend the skins so that they may not be damaged by rubbing against the stones at the bottom of the stream.

Dry skins necessarily require a longer soaking; and to facilitate the operation, it is necessary to remove them from the water frequently, and each time to stretch them, beat them under feet, and work them upon the wooden horse, as shown in Fig. 25, with the fleshing-knife, Fig. 26, and then leave them to drain. The fleshing should

Fig. 25.

be repeated once or twice. This manipulation softens, cleanses, and stretches the hide.

Fig. 26.

The working and scraping must be continued until all the slimy and other animal matters which are prone to

putrefaction are removed. No definite length of time can be prescribed for the soaking of the skins; they are to remain in the water until they have become supple, and the intelligence of the workman must determine when this point is attained. If the soaking should be too prolonged, the skins will acquire a tendency to putrefy. It need hardly be mentioned that skins which have been *salted and dried*, require a longer soaking than those that have only been dried.

The working and softening of the hides upon the horse, or beam, are considered indispensable operations by all experienced tanners, though there are some who omit them.

When the skins have been all soaked and washed, as above directed, and are sufficiently supple, they are returned to, and left in the water for five or six hours. In a fresh running stream they may remain as long as eight; but in still water not more than five or six hours. Reference is here made exclusively to the large hides; for cow-skins may be left without danger of injury, for twenty-four, and calf-skins forty-eight hours; some attention being always given to the nature of the water and temperature of the atmosphere. It must be remembered that a too long-continued soaking in the same water exposes the skins to the danger of putrefaction; and the rapidity of this decomposition is proportional to the amount of filthy foreign matter contained in the water.

The skins which have been well salted, but not dried, may be cleansed in forty-eight hours; but they may be left to soak, without injury, for three or four days. They must, however, be withdrawn once daily, left to drain for two hours, worked with the back of the fleshing-knife, and well rinsed in water. These manipulations are necessary not only for removing salt and dirt, but also

for rendering them soft and supple. When they are taken from the water for the last time, the rinsing must be vigorous and thorough.

At Saint Saëns, the mode of soaking hides is peculiar to that place. They commonly use the dry hides from South America, which are placed directly in vats filled with lime-water, and left for six or ten days, care being taken to work them in the usual manner at frequent intervals during the soaking. These vats are eight feet long and five feet wide.

The skins are softened by the action of the lime, and rendered more easy to be handled, and it is at this stage that the defective parts may be detected by critical examination. Sometimes they are so damaged as to be suitable only for the manufacture of glue.

In the Belgian town of Liege, where they mostly use the dry hides from Brazil and Caraccas, there is no allotted time for soaking. They follow a method which, though laborious, prevents an over-soaking of the hides. After four or five days they examine each vat, and withdraw such hides as have become soft, and leave the rest. This culling process is repeated daily, until all the hides have been withdrawn. The skins which require the longest soaking, and are taken out the last, are those which have been damaged by sea-water during transportation.

As soon as the hides are taken from the vats, they are worked upon the horse, and then returned to the water. On the following day they are thoroughly rinsed, and placed in the drying-room. The working, or frotting, is solely to remove the wrinkles and stiffness of the dry skins. These manipulations are unnecessary for the green hides.

Although some manufacturers contend that the quality

of the leather is improved in proportion to the duration of the soaking of the skin, it is still undeniable that, when it exceeds a certain time, the skin acquires a tendency to decomposition, and the quality of the leather is thus impaired.

Of the Influence of the Soaking-water upon the Quality of the Leather.—It is a mooted point whether the nature of the water used for soaking has any influence upon the quality of the leather. In the absence of any positive knowledge, it is perhaps better to take the affirmative side of the question. Dessables says, it is undeniable that the leathers known as calf-skins, and which by their very nature and destined uses should be soft and supple, require a soft, fresh water, and consequently that it will be difficult to make them with that which is hard.

We will treat this subject by giving a chemical view of the different kinds of water.

In modern chemistry water is known as oxy-hydric acid, or protoxide of hydrogen. When pure, it is inodorous, colorless, transparent, elastic, and strongly refractive of light, and a conductor of heat and electricity. It is compressible, with disengagement of light, boils at 212° F., and freezes at 32° F. Those waters which are called *potable*, or *soft*, will dissolve soap, while those that do not possess this property, are not so good for drinking, and are termed *hard*. The former are nearly free from soluble matters, while the latter contain calcareous and other salts, which they have taken up in their transit through the soil. The ultimate composition of absolutely pure water is 88.9 parts, by weight, of oxygen, and 11.1 of hydrogen. The agreeable taste of fresh water is due to the atmospheric air which it contains; when this is expelled by boiling, water becomes insipid.

Rain-water.—The purest rain-water is that which falls in the country, or in sparsely settled localities, where there are no noxious emanations. That which is first collected should not be retained.

The soluble impurities of rain-water are those which it has dissolved from the atmosphere, and consist of minute traces of chloride of sodium, carbonate of ammonia, and carbonic acid. The suspended matters with which it is sometimes charged, are taken up in its flow over the house-roofs. The rain-water after thunder-storms contains, in addition to the above constituents, small traces of nitric acid and of nitrates.

Snow-water.—According to Bergmann, snow, which is crystalline rain-water, loses the gases held by it, upon being melted.

Spring and Fountain-water.—Rain-waters, in traversing earthy strata, gradually collect in cavities, from which they gush to the surface. It is evident, therefore, that water, in its transit through the soil, must become charged with such constituents thereof as are soluble in it; and consequently the purity of the water is proportional to the insolubility of the earths through which it has flowed.

The purest spring-waters contain air, carbonic acid, and minute quantities of hydrochlorate and carbonate of soda.

River-water.—River-water does not differ materially from spring-water, since it is from the union of the latter with rain-water that it is formed. Sometimes, however, it is purer, from having deposited its suspended matter, and also a part of that held in solution, which generally happens when it traverses a long and silicious bed. If it pass over or through limestone, or other strata containing soluble ingredients, it becomes less pure.

Lake-Water.—Water of lakes differs from that of rivers only in being more highly charged with the soluble principles of the soil upon which they rest, a condition which is promoted by their state of quiescence.

Marsh-water.—This kind of water is in even a more permanent state of stagnation than lake-water. When its content of organic matter is large, putrefaction ensues, and a part passes off in gaseous form, while the remainder subsides as insoluble precipitate. If the decomposition has not been complete, some of the organic products will remain in solution, and impart a disagreeable taste.

Well-water.—It might be inferred that well-water is analogous to that from fountains and springs; but it filters through the soil much more slowly, and remains stagnant usually at greater depths; and, consequently, is more readily impregnated with the soluble constituents of the soil. Hence it is that well-water is generally *hard*, because it contains earthy salts, and more particularly sulphate, or bicarbonate, or hydrochlorate of lime, which render soap insoluble in it.

According to Sennebier, there is more carbonic acid in well than in spring water.

Well-water from the vicinity of the sea has a brackish taste, and contains the same constituents as sea-water, but in diminished proportions.

When well-waters are very hard, the addition of a little alkaline carbonate will decompose the lime-salt, and render them potable.

It is very evident that rain-water is the purest; but all drinkable waters are applicable for tanning purposes. To impart softness to hard waters, the French tanners add a solution of pigeon or chicken dung to the vat, and

Fig. 27.

stir it in thoroughly by means of the implement, Fig. 27. The hides are then put into soak. In some tanneries, instead of washing the skins in the river, they soak them in troughs.

Waters containing iron blacken the hides, and render the leather brittle.

In the Paris tanneries, it is customary to purify the water by allowing it to infiltrate through spent tan. For this purpose there is a series of three vats, charged similarly with spent tan; and, as the water which is poured into the first vat, is drawn through a cock at the bottom, it is transferred to the second, and, ultimately, to the third vat. In this manner all kinds of water may be rendered available for tanning. As thus rectified, it contains a little tannin derived from the spent tan, which renders it particularly adapted for the early part of the tanning operation.

Experience certainly proves the superiority of some waters over others for tanning purposes; but on what particular quality of the water this superiority depends, chemists have not yet been able to determine.

The safest course is to prefer those waters which contain the least soluble matter, particularly earthy salts, such as lime and magnesia; for these certainly reduce the tanning power of the ooze, by combining with some of its constituents.

The suspended matters, consisting of mud, &c., as well as the soluble organic matter, which imparts to water a bad taste, may be removed by filtering the water through clean gravel and fresh charcoal.

If the lime exists as bicarbonate, it may be separated from the water by adding lime-water, which precipitates it as an insoluble neutral carbonate. Boiling produces

the same result, by expelling the bi-equivalant of carbonic acid.

SWELLING, OR RAISING.

The second process to which hides are to be subjected is termed *raising*, and is that by which the pores are distended, the fibres swollen, and the hair loosened. These results are effected by means of alkaline or acid solutions, and by fermentation. Milk of lime is the alkaline liquor generally employed. Lime-water has been proposed as a substitute, but it is less permanent in its action, and requires frequent renewal in order to insure the perfect cleansing of the hides.

Swelling by Lime.—This is the oldest and most objectionable method. The lime-vats in which the hides are to be soaked, are made either of wood or mason work, sunk in the ground, and plastered interiorly with hydraulic cement. They may be round or square, and of dimensions proportional to the number of hides to be soaked. The usual size is five feet square, and the same in depth.

About a peck of lime usually suffices for a large hide; and, accordingly, the number of skins to be treated in each vat must determine the proportion of lime to be added. Circumstances, however, may render it necessary, sometimes, to increase the quantity. The practice adopted in some factories, of economizing lime by partially substituting ashes, lye, or pigeon and dog dung, &c., is a very reprehensible one, as it produces injurious effects.

To make a fresh vat, quicklime is thrown in, covered with water, and agitated with a stirrer, Fig. 28, until it

has become slaked and passed into milk. In this state the vat is left for some days; after which, it is ready to receive the hides.

Fig. 28.

The vats are distinguished as *dead*, *weak*, and *live vats*. The *dead* vat is that which has been nearly exhausted of its strength; the *weak* is that which has only been used enough to deprive it of a portion of its force; and the fresh or *live* vat, is that which has not yet been worked. In the progress of operations, the live vat passes successively into the weak and the dead vat.

The three vats are termed the *raising series*, Fig. 29.

Fig. 29.

The raising should be commenced in the dead vat, and continued in consecutive order through the series to the live vat. In some factories the series consists of as many as twelve vats; and, in this case, there should be a gradation in the strength of the liquors. The duration of this operation varies in different localities. Some tanners leave the hides in the vats for three months, while others soak them for eighteen months. The old routinists, according to Dessables, give the hides a soaking of ten, twelve, and even fifteen months; and then, when they have become sufficiently softened, transfer them to a dead vat for eight days, at the end of which time they

are withdrawn, hung up for eight days, and again placed in the same vat for eight more days, and so on. These consecutive operations are thus continued for two months, or until the hair can be readily detached.

The graduation of the vats varies in different localities. In those parts of France where the series consists of twelve vats, the first two are *dead*, the four following *weak*, and the last six, *fresh* or *live vats*. Where the system comprises only five, the first two are dead, and the three last live vats.

In Brittany, many tanners, believing that the hides are raised better with the hair on than in *pelt*, give six live vats, and do not remove them until after the fourth and even the fifth.

In Auvergne, they give three raisings of a month each, with a mixture of lime and alkaline lye.

We cannot see the utility of so many vats, for when the skins have soaked to the saturating point, a continuation of the treatment is supererogatory. Generally speaking, three or four vats, with skilful manipulation, suffice for any kind of skins. Delalande contends that from ten to twelve months are requisite for thorough soaking; but the experience of all good tanners proves that two months are sufficient, and that in this time the skin becomes soft and capable of being readily cleansed and freed from its hair.

According to Curandeau, only ten or twelve days are required for the transit of the hides through the three lime-vats. He also thinks that a longer time would be useless, if not injurious, and that the shorter the soaking the greater is the weight acquired by the hides in tanning. Malepeyre adds that it is now established: 1st, that it is sufficient to leave the hides in the pits for twenty-four hours, and an equal length of time in stack;

2d, that this operation should not continue for more than six or eight weeks at farthest; 3d, that three, or at most four good vats are sufficient; 4th, that, after this interval, the hides are easily cleansed; and when, on the other hand, the treatment is prolonged, the hides become dry and parched; 5th, that after three or four pits, the hide will have swollen to the fullest extent; and, finally, that independently of these objections, there is a great waste of time, lime, and materials, in the old method of steeping for from ten to fifteen months.

Stacking the hides, is to pile them one upon the other at the side of the vat, as they are drawn from it, and thus leave them remaining (*in retreat*) for a shorter or longer time, before returning them to the bath for another wet.

Piling enables the working of sixty hides in a vat of capacity for only thirty, by having one batch to take the place of the other in alternate operations. For example, while one set of thirty is in *retreat*, the other should be in the vats, and *vice versa*; so as to save time.

The vats should be covered; and as the skins in *retreat* are liable to become hard by exposure to the sun and air, they should not be kept in that state longer than is necessary. Covers prevent this as well as the retarding influence of cold; for, while the liquid is frozen on the surface, it is inactive.

At every *handling*, that is, upon each return of the skins to the vats, or when new ones are put in, an intimate mixture of the water and lime at the bottom should be made by a thorough stirring of the liquor. At this time, a workman at each end of the vat, by the aid of tongs (Fig. 30), arranges the hides in it so that they may lie smoothly and firmly. The suspended lime, by its greater weight, soon subsides upon the hides, and the

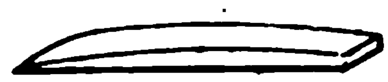
Fig. 30.

supernatant liquor which should cover the hides to a depth of some inches, will be clear and transparent. As the greater portion of the lime is in contact with the skins at the bottom of the vat, its action is more powerful upon them than on those above, and, consequently, in recharging the vat after stacking, the order of position must be reversed; those that were originally placed first, must be then last, and *vice versa.*

Should the vat, as often happens, become too weak to produce the desired effect, it must be strengthened by the addition of the quantity of lime necessary to restore its force. The advantage is thus obtained of giving the hides the benefit of two vats in one. This new addition of lime should be made while the skins are out of the vat.

For removing the hair, the *scraping-knife* alone must be used. This is a dull-edged instrument, which is not liable to damage the skin by cutting it, while it is all-efficient in scraping off the hair. It is a bad practice to use the slate, or *rubber* (Fig. 31), which, being rough, may scratch and damage the hide upon its grain side.

Fig. 31.



The use of sand, ashes, or other similar auxiliaries for removing the hair is very improper, as they attach themselves to the surface and thus in-

crease the trouble of cleansing it. It is also a bad practice to wait until the completion of the soaking before scraping off the hair, because the lime will, in time, act upon the hair itself.

After the removal of the hair, the skins are rinsed, and replaced in the dead vat, and so on consecutively through the series to the live vat. It suffices to leave the hides for fifteen days in each of these vats, but care must be taken to stack and replace them every twenty-four hours.

"The force of habit, and perhaps the use of the Kermes oak bark," says Tournal, "causes many tanners to persist in the use of lime. But if, in rinsing, great care is not taken to remove every trace of lime, as is known when the liquor expressed by the dull knife employed for scraping them on the beam runs very limpid, the minute traces remaining, will, by abstracting carbonic acid from the air, become insoluble, and render the skin dry, brittle, and perhaps useless. These faults are not, however, solely attributable to the carbonic acid of the air, but also to the formation of tannate of lime, as well as of the stearate and oleate of that base, which are generated by the presence of fatty matters always existing in the hides."

"The tanners," says the same authority, "who use the Kermes, pretend that its *warm* nature imparts stiffness to the leather, and that consequently the only available mode of *raising* is by means of lime. They own that the sour tan-juice and barley processes distend the pores of the hide much more than lime; and that the tanning principle of the Kermes, having a tendency to combine rapidly with the hide thus swollen, imparts an unnatural stiffness to the leather. The reality of these assertions may be readily determined by tanning with Kermes

some hides which have been raised by the sour tan-liquor process."

In quoting these passages we have adhered to the language of Tournal. We will add that, according to our experience, the bark of the Kermes oak is richer in tannin than that of the ordinary oak, and that admirable leather may be prepared by tanning with it skins which have been raised by sour tan-liquor.

There are certain drawbacks to the liming process, which are worthy of enumeration. Firstly, the contact of caustic lime alters, more or less, the texture of the hide, and permits it to penetrate the pores, and remain in them in the state of caustic lime, carbonate, or lime-soap. The repeated rinsings in water, and workings, only partially remove the lime, which is a serious impediment to perfect tanning. It hinders the ready penetration of the tan liquor and the perfect combination of tannin with the skin, and so obstinately resists removal during all the manipulation that a portion is found even in the best leather. When, however, the latter is to be converted into glazed leather, the curriers first remove all the lime by a particular method.

Notwithstanding that experience is so opposed to the use of lime, the careful and elaborate experiments of Dr. J. Davy (*Chemist*, 1850), show that its action upon animal textures generally is rather antiseptic than destructive. Its corroding influence is limited to the cuticle, hair, nails, and all gelatinous tissues. These latter become soft and gelatinous, owing, doubtless, to a combination which they form with the lime, for on analyzing the ash of the cuticle thus treated, a large increase of its normal contents of that earth was obtained.

The matters were steeped in milk of lime, kept caustic

in close vessels, by the entire exclusion of air. After treatment they ceased to be putrescent.

The disadvantages of the use of lime have led to the substitution of less objectionable agents, which we will proceed to treat of in succession.

Raising by Acids.—Some tanners substitute an acid liquor for the milk of lime; for example, the Tartar-Calmucks use sour milk for this purpose. Pfeiffer has proposed the acidulated water obtained by the distillation of lime and peat. Sometimes a little sulphuric acid is added. In fine, this acid in a dilute state, as also all the vegetable acids, will produce the same effect. That which is formed by the fermentation of barley meal, of rye, and of tan bark is acetic acid. Acids have the double advantage of loosening the hair, and swelling the hides at the same time.

In some tanneries, the skins are softened by sprinkling one-half with salt, and folding the other half over it. They are then piled up and covered with straw. Fermentation speedily ensues; and they must be turned several times daily, until they have attained that state in which they can easily be depilated. The same result can be attained without the use of salt. They are to be piled upon a bed of straw and covered in like manner. After twenty-four hours, they are turned and then examined twice daily, so that the proper point may not be exceeded. In some tanneries, the hides are imbedded in horse manure. In others they are covered with tan, or some imperfect conductor of heat. Incipient putrefaction and consequent loosening of the hair may also be effected by suspending the hides, which have been left lying in a heap for several days, in a close room, kept above the ordinary temperature by a smouldering tan

fire. Better results might be obtained by circulating a current of steam through the apartment.

All methods of fermentation are termed *sweating processes*. But whatever the process followed, the skins, as soon as the hair begins to yield readily, are to be spread upon a wooden horse, and scraped with a dull-edged knife. In this manner the hair and outer skin are fleshed or scraped off. As the outer skin is of a nature different from that of the hide, and does not unite with tannin, it must necessarily be removed in order to allow the free passage of the tan liquor through the skin proper, and thus facilitate the tanning process.

Depilation by Steam.—In many tanneries, the depilation by milk of lime is superseded by another method, which subjects the hides in heaps, to a slight putrefactive fermentation in heated chambers. It is difficult, in warm seasons, to control this fermentation; and sometimes it is even necessary to salt the hides. After some days, the epidermis becomes loose and detached, and may be readily scraped off with the hair.

Belbut, in Paris, and Robinson, of Delaware, employ steam as the heating medium, in an arched chamber of eighteen feet in length, ten feet in height, and ten feet in breadth, and lined interiorly with cement. The steam is introduced beneath a false bottom of wood, perforated with numerous holes, and serving as the bed for the support of the hides. As the steam condenses, it should be allowed to escape through an opening at the base of the chamber.

The temperature of the *heap* should be maintained at between 70 and 80° F., and precaution should be used to keep it uniform, for it must be remembered that the joint action of heat and moisture may dissolve the gelatine, and thus cause the hides to be scarred with pits. In

twenty-four hours, the process is completed, and the hair may be scraped off in the usual manner. If the hair falls from the hides when they are taken out of the heap, it is owing to incipient decomposition of the surface. Beef hides weighing from eighty to one hundred pounds experience a loss of from twenty-four to twenty-eight pounds.

Depilation by Caustic Soda.—Boudet proposes caustic soda as an advantageous substitute for the milk of lime for raising and depilating hides. The liquid for the purpose is prepared by decarbonating a very dilute solution of soda ash with a sufficient quantity of milk of lime, allowing repose, and decanting the clear supernatant caustic soda-lye by means of a syphon. The hides immersed in this liquor swell out rapidly and considerably, and are ready to be scraped in two or three days. Moreover, the alkali forming soluble soap with the fatty portions, facilitates the cleansing, and produces a smoother grained side than is common. Hides thus prepared are said to imbibe the tan liquor more rapidly than those which have been treated with lime, to undergo the entire process of tanning in one-third of the time, and to suffer less loss than those prepared by the usual process. Forty-four pounds of sal soda dissolved in 132 gallons of water, and mixed with 33 pounds of slaked lime, suffice for steeping 2200 pounds of fresh hides.

Depilation by Sulphurets of Calcium and Soda.—Boudet, in trying the old method of depilating by means of a mixed paste of orpiment (sulphuret of arsenic), and caustic lime, observed that the arsenic was without any direct influence upon the hair, and that the depilatory action was due to sulphuret of calcium in its nascent state, formed by the reaction of the lime upon the sulphuret

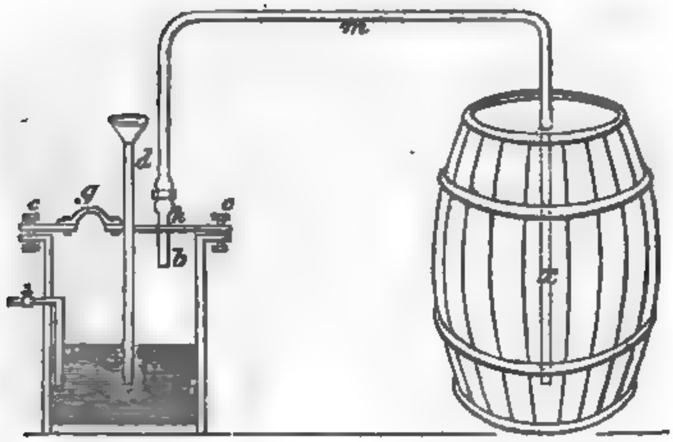
of arsenic. Acting upon this observation, he replaced the orpiment by sulphuret of calcium, which, when made into paste with lime, acted so promptly, that, after 24 or 36 hours' contact, the skins were completely depilated. The lime alone has no depilating effect, and the sulphuret of sodium only a partial action. This principle was originally announced by Martins, and first applied to tanning purposes, in 1840, by Boetger.

This mode of preparing the hides is said to render them highly susceptible of being quickly tanned. Experience has yet to decide what influence it has upon the leather. The prejudice of tanners, so far, is against this method, which, it is said, surcharges the leather with an amount of water that escapes by evaporation during storing, to the great loss of the dealer; but we do not think that this objection is tenable.

The vat formed of a mixture of potash, lime, and orpiment (sulphuret of arsenic), as proposed by Abram and Coste, of Marseilles, is much less convenient than the preceding, and is liable to numerous objections; not the least of which is the danger to be apprehended in manipulating with a liquor containing such a poisonous ingredient as orpiment.

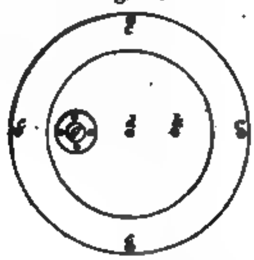
The hydrosulphuret of calcium is made by supersaturating a very thick milk of lime with sulphuretted hydrogen gas. The apparatus necessary for the purpose consists of a generator and a receiver, as shown in the drawings below. Fig. 32 represents a leaden generator, of cylindrical form, and about thirty-six inches high, by twenty-four inches diameter, supported by a wooden casing or jacket. This vessel has a movable cover of cast-iron, with a projecting ledge, through which pass the bolts, *c*, *c*, for fastening it down. In this cover there

Fig. 32.



are three openings, as shown by Fig. 33. The larger one, *g*, is the *man* hole, for the admission of the sul-

Fig. 33.



phuret of iron, and for cleaning out. Of the two smaller, the centre one, *d*, receives the stationary funnel tube, *d*, through which the dilute sulphuric acid is to be introduced. The side hole, *k*, contains a short tube, *b*, with a screw at its upper end, for coupling the flexible exit tube, *m* (made of lead, or, what is much better, vulcanized caoutchouc), which is to convey the generated gas into the lime paste, contained in the closely covered receiver, *x*. The pipe, *o*, running down the side of the

generator, interiorly, is for the coupling of the steam conduit, when the admission of steam is desirable.

The protosulphuret of iron, a cheap material, sold at the rate of five dollars per hundred weight, rests upon the bottom of the generator, as shown at *s*. It consists of iron and sulphur in combination. When the sulphuric acid and water (in mixture of one volume of the former to three or four volumes of the latter) are poured in through the funnel tube, *d*, to the height indicated in the figure, chemical action immediately ensues. The water, which is composed of oxygen and hydrogen, is decomposed, and the former gas goes at once to the iron, which is deserted simultaneously by its sulphur, and thus becoming an oxybase, indulges its affinity for the sulphuric acid, and unites with it to form sulphate of iron or copperas. The hydrogen disengaged from its oxygen, seizes on the sulphur at the moment of its elimination, and, uniting chemically with it, forms sulphuretted hydrogen, and makes its exit through the tube, *m*, leading into the lime-milk, with which it combines as hydrosulphuret of calcium. The current of gas must be uninterrupted until the complete supersaturation of the lime, which may be known when a small portion taken out, and exposed for fifteen minutes to the air, still emits the characteristic fetid odor of sulphuretted hydrogen gas. Whenever the flow of gas slackens, it must be hastened by pouring in a small quantity of undiluted acid. The occasional admission of steam through the pipe, *o*, by applying heat, promotes the reaction. When the paste is saturated, the connection of the pipes *m* and *k* must be severed, and the generator emptied of its contents, through the *man* hole, *g*, so that it may be ready for a fresh charge and new operation.

The receiving vat should be of wood, strongly bound

with iron hoops, and fitted with a cover and appliances for keeping it close enough to confine the gas, but not so tight as to cause an explosion. It should also be fitted with a revolving stirrer or churn, so as to facilitate the agitation of its contents, which is necessary to insure thorough saturation with the gas.

The paste should be made in quantities as required, for it must be used without much delay, as the action of the air soon renders it inert, by converting it into sulphate of lime.

It is applied to the green or softened hides, by spreading them upon a table, and paying over the hair sides with a thin coating, in such a manner that it may reach the surface of the skin. Two skins thus treated, are placed with their hair sides together, and are pressed between boards. In two hours the hair is entirely loose; and, though much of it might be removed by mere washing, it is necessary to scrape in the usual manner. The paste is well known as a rapid depilatory, and being totally destitute of action upon the hide, it leaves its surface smooth and uninjured. This process is highly commended in France; but, as it has not yet been used in this country, we can add nothing, from experience, in regard to it. It certainly is an expeditious plan, and seems so feasible and economical in other respects, that we recommend the trial of it upon a large scale.

A serious inconvenience in the use of this paste is the offensive and unhealthy odor which it disengages; which, with due caution, however, may be avoided. Sickness, colic, and pains in the chest are some of its ill effects upon the system, which are increased to asphyxia or tetanic convulsions, when the odor is concentrated and the exposure to it prolonged.

Prof. J. C. Booth (*Encyclopedia of Chemistry*, p. 902),

who has used this gas extensively in manufacturing processes, on the other hand, doubts its destructive influence upon the health, unless the atmosphere containing it is surcharged and confined. He says that, "although offensive, it may be inhaled by men, when largely mixed with air, without apparent injury; and, even when fresh, it may be respired in large quantity, without producing any other effect than a temporary faintness. The effect upon one workman was a pleasant, lethargic feeling; and I have breathed a strong mixture of it with air, repeatedly, and never experienced the slightest injury to my health."

Refuse-lime from the gas works, used in purifying the gas, contains, when fresh, a large proportion of hydrosulphuret of calcium; and might be substituted for the prepared paste; but it is very slow, and much less certain in its action.

Warrington's Process.—Warrington proposes the use of carbonate of soda or potassa for soaking; and the employment of hydrochloric or nitric acid, and also certain vegetable matters, for facilitating depilation, and promoting the swelling. See Chapter XIX. for details.

Cool Sweating Process.—This method of unhairing hides has been in general use for some time in New York, New Hampshire, and the northern part of Pennsylvania; and experience confirms all the advantages over the older processes, claimed for it by the inventor. It is said to give a gain in the leather of 70 to 80 per cent. on the dry hide; while the "warm sweating" process yields much less, and the "liming" only 30 to 40 per cent. It, moreover, obviates the necessity of previously subjecting the dry hides to the fulling stocks, which, by producing an undue distension, renders the leather thin, weak, and limber, beyond the required degree.

The process and apparatus, the description of which we take from the *Journ. Frank. Instit.*, 1843, are as follows:—

"First, a vault or pit should be prepared for the reception of the hides; which, for convenience sake, should be twelve feet long, twelve feet deep, and ten feet wide. The walls may be built of stone or of a planked frame. There should be one alley, or vestibule, for entrance, not less than six feet long, having a door at each end, the outer one made double, and filled in with tan, to prevent the communication of warm, dry air from without. A ventiduct, made of plank, ten or twelve inches square, should extend from the centre of the bottom of the vaults, three or four rods therefrom, and placed not less than four feet below the surface of the ground. This serves both as a drain for discharging the water of the vault, and to admit damp, cool air, to supply the place of that which has become rarefied, and thus keep up a current through the ventilator at top. The ridge of the roof may be level with the surface of the ground; and, on the ridge, extending its whole length, set up two planks edgewise, two inches apart. The space between these is to be left open, but the remainder of the roof must be covered with earth, to the depth of at least a yard. The earth covering upon the vault and drain is to preserve a low temperature for the hides, so that they may unhair without tainting. Spring-water should be conducted, either in pipes or logs, around the angles formed by the ceiling with the walls of the vault, from which water should be allowed to flow in small quantities, either forming a spray, or falling so as to raise a mist or vapor, and saturate the atmosphere of the vault. The temperature of spring-water is generally about 50° F. Water evaporating at all temperatures, it is plain

that, if a constant supply be afforded, this evaporation, by requiring a large portion of heat, would keep the temperature of the vault nearly uniform. To suspend the hides in the pit, place three bars lengthwise, at equal distances, near the ceiling, with iron hooks, two or three inches apart, inserted therein. Soak the hides as usual for breaking, then hang them singly upon the hooks by the butt, so that they may be spread fully open. In the course of a few days, when the hair begins to loosen upon the upper parts, take them down, raise the middle bar, and hang them by the other end, until they will easily unhair. The hides should not be broken until they are taken from the vault and ready to unhair. In a good vault, where the thermometer ranges from 44° to 56° F., which it should never exceed, and where there is a free circulation of *damp* air, hides generally require six to twelve days for unhairing. When the temperature falls below 44°, the ventilator should be partially closed; and when it rises above 56°, *cold damp* air must be forced in, or an increased quantity of cold spring-water may be thrown from a hose or otherwise."

The hides carefully carried through this process, when received by the tanner from the beamsman's hands, are free from all extraneous matter, and contain all their gelatine, albumen, and fibrine, in an unimpaired state. It is not, as the inexperienced suppose, a fermentation which produces the unhairing, for there is no ammonia generated, and this is universally a product of the putrefactive decomposition of animal matters. "The action is confined to the *surface or grain* of the skin, expanding the outer portion, softening the roots of the hair, and thus rendering its removal easy. Its effect is due to the *softening* action of the vapor, and it is a simple case of

absorption and swelling of the tissues of the skin and roots of the hair."

Liming, which requires an immersion of three or more weeks, it is true, loosens the epidermis and hair, and renders their removal easy by fleshing; but, at the same time, injures the gelatine and albumen, and "swells" the hide so excessively, and expands its texture, as to weaken the leather. Moreover, if it should be what is termed *high limed*, the leather is light, and not durable; bad properties, which it also possesses, but in a modified degree, even when prepared by *low liming*. Moreover, the ill effects of the *bating* which follows, are an additional drawback. The bate consists of a liquor made from the dung of domestic fowls, and immersion in this removes the lime and reduces the skin to its original thickness. It acts by means of the muriate of ammonia which it contains. This salt is decomposed by the lime, which drives off its base, the ammonia, and taking up with the muriatic acid, then becomes soluble muriate of lime, and passes off with the rinse water; but carries with it, at the same time, a portion of the gelatine, rendered soluble by the putrefaction of the organic matter of the bate, which undoubtedly occurs. There is emitted, besides, an offensive odor, which is injurious to the health of the workmen.

Suspending the hides in close chambers, heated slightly above the ordinary temperature of the atmosphere, and thus loosening the epidermis by incipient putrefaction, is as objectionable as the liming or bating process.

The German method of sweating the hides in piles, or stacks, under a covering of tan or some other imperfect conducting material, in order to confine the heat generated by the chemical decomposition going on within, is fully as disadvantageous as either of the foregoing.

The present process, its author says, has been proved by experience, to obviate all the evils arising from "hot sweating," or from unhairing the hides by the lime process.

Vauquelin proposes the substitution of machinery for the use of lime, arsenic acid, and salts; but we shall delay a description of it until we come to speak of his process for tanning.

Turnbull, taking advantage of the property which sugar possesses of forming a soluble saccharate of lime, employs it for removing any excess of that base which may remain in the hide. This process, of which we shall speak more fully hereafter, is said to be expensive; but it shortens the time of tanning, and improves the quality of the leather.

Raising by Barley Dressings.—The raising and depilation of hides by barley is more effective and rapid than when lime is used. It is a common error that hides, treated in this manner, require more working in the water. Indeed, the very reverse being frequently the case.

There should be a series of vats of this acid liquor, varying in strength. The hides are first soaked in the vat containing the weaker liquor, then pressed, and afterwards washed. After several repetitions of these manipulations, the hair becomes loose, and easily removable from the skins.

In the tannery of Bouillerat, at Paris, the proceeding is as follows: The hides, as they come from the slaughter-house, after being soaked and fleshed, are put through the *dressings*, that is, subjected to the action of fermentable barley water.

They remain three days in the first or dead "dressing," and as much longer in the second, when they are freed from their hair, and placed in a third vat, in which

they dilate, swell out, and acquire consistence. They are taken out only once, daily, from the dead dressing, and twice from the others. At each time they are laid in heaps, and there left *in retreat*, during an interval of three hours. After these three dressings, the hides are subjected to a fourth, which is termed the *new dressing*. This latter is made with 145 pounds of well-ground barley meal. From this quantity 10 pounds are taken out and made into a leaven, by being kneaded with warm water, and left to ferment for twelve to fourteen hours, in which time it sours and becomes sufficiently ripe for the operation. This leaven is thinned out, in winter with boiling, in spring with hot, and in summer with tepid water, in sufficient quantity to form the dressing. The vats for these operations are iron-bound cedar tubs.

The hides are passed from the new dressing into another similar one, and are allowed to remain four days in each. Eight or nine hides are generally worked at one time.

The series is composed of four or five tubs, or vats. The first dressing is intended to wash the hides, the second for depilation, the third to swell them and impart body; and the two others, which are new, complete the action of the third. These preparations, termed *white dressings*, require five weeks in summer and six in winter. Fig. 29 represents the dressing series.

After having gone through the white dressings, as above, the hides are carefully washed and placed in the red preparation, composed of 220 pounds, or four baskets, of tan, well mixed with two and a half hogsheads of water; and are left in the mixture for fifteen days during summer, and for one month in the winter. It is, however, necessary, during the first five days, to take the

hides out, once daily, in order to be assured that the supply of bark is sufficient. When the skins come from the preparation, they are to be washed and placed in the vats. Eight or nine skins may be handled at one working.

At Abbeville, which is renowned for the number of its tanneries, and the quality of its leather, the tanners adopt the following method:—

For sixteen hides, 48 pounds of unbolted barley meal are put into an open-mouthed tub or hogshead, and mixed with some sour paste, made of flour, thinned out with hot water. To this mixture about half a pound of yeast is added; fermentation soon follows, and in from fifteen to sixteen hours the leaven is formed. This leaven being thoroughly mixed with 150 pounds of meal, in a tub of water, forms what is termed the new dressing or preparation.

The same gradation as with lime is observed as to these dressings. Before the hides are worked, they should be cut into halves, and always placed with the flesh side upwards.

The hides remain two or three days in the old, five or six days in the weak, and twelve or fifteen in the third and fourth, which are the strong or new dressings. Sometimes the hides are sufficiently raised at the fourth dressing, and then they are taken out, while the unfinished ones are put into a fifth dressing, and left until they have acquired sufficient swelling. During summer, the hides are drawn out twice, and in winter once, and left to drain for an hour, each time, upon a trough conveniently situated near the tub. The course of barley-dressings requires about six weeks in summer, and much longer in winter, for cold retards their action.

According to Delalande, in Sedan they use nine or ten

small tubs, of about six hogsheads each. There is a regular gradation in their strength; for example, after the first operation, the second becomes the first, the third second, and so on progressively.

Five hides are placed in the first tub, and, after remaining therein from twenty-four to forty-eight hours, are transferred to the second, which is a little more sour, then to the third, and so on successively, through all the remaining tubs, until they have passed through the whole ten. The last, as we have already said, is always the strongest, and the first the weakest.

If, as often happens, the skins should attain the necessary degree of dressing at the fourth, third, or even second tub, it is needless to treat them further. These sour liquors, even after having served for ten successive operations, still retain acidity, and are again applicable, in proportion to their degree of strength, which must be determined by the experience of the workman.

All tanners are not agreed as to the exact time for depilation; some proceed to this step after the second dressing, while others, holding to the old adage, that the hides *raise* better with the hair on than in pelt, do not dehair until after the dressing before the last.

After the skins have been treated, they are washed in clear water, for the removal of dirt; and, when they come from the last dressing, they are again rinsed and scraped over with the fleshing-knife, Fig. 26. Finally, they are again put in water, and brushed over on the hair side.

Some few tanners, after this manipulation, lay the hides in the vats; but the majority first subject them to a red dressing. This latter dressing is given by spreading the hides in a vat, one above another, and placing between each pair two or three handfuls of ground

Fig. 24.

bark. Water is then added until the hides are submerged. This process requires two days, and the hides require only one withdrawal to allow them to drain. In giving them the finishing wet, care must be observed to supply bark where it may be wanting.

This method of cleaning and unhairing is equally objectionable as the lime process; and has, besides, additional disadvantages. Exposure to a very low temperature destroys the efficacy of the bath, which is not restored, as in the case of lime, when the bath thaws. And the leather is also exposed to the risk of being injured by the putrefactive fermentation of the materials.

The English have, for a long time, used the barley dressings for their coarse hides; but, with them, the operation of raising is completed in six days. The hides pass through four or five dressings, and progressively from the weak to the strong preparations. The hides remain only twenty-four hours in the last vat, which is new, and which has been soured for fifteen days. It is made by diffusing about sixty pounds of barley meal in hot water. As a long time is allowed for the development of acid, and, consequently, the dressing is more active than ordinary ones, it becomes necessary to watch carefully when the required point is reached, otherwise the hides will suffer injury.

Barrois, an eminent French tanner, pursued a method

somewhat different from the preceding. According to Delalande, he worked five series, of four tubs each, at a time. These tubs were three feet and a quarter in height, and five feet in diameter, and of capacity for eight hides; each series comprising thirty-two hides. It is necessary to take out all the hides, twice daily, during the dressing.

Every four days a new preparation is made up in one of the four tubs; it is deposited in that, the dressing of which was the weakest, after running it off and washing out the vat. The third vat then becomes the last or weakest, and that which was the first and strongest, becomes the second.

The eight hides remain eight days in the fourth or weakest vat; four days in the third, which then becomes the weakest; then the same length of time successively in the second and the first, after six days' residence in which, they are stripped and deposited in the fresh series. In this they remain four days, in a dressing which has only been used once; four days more in another similar one; and four days each, in two fresh vats.

Each fresh preparation for eight hides, is composed of 145 pounds of ground barley, and the leaven is made with 30 pounds of this quantity, mixed with yeast and hot water.

This interval of thirty-two days suffices for the requisite preparation of the hides, either in summer or winter; but, in the latter season, hot water is generally used in the proportion of five or six bucketsful to each preparation, in order to hasten the fermentation.

A barley-dressed hide of 100 pounds, takes about 200 pounds of bark, as follows: 25 in the red dressing, 30 in the first powder, 25 in the second, and 20 in the third.

The freshness of the preparations may be maintained by the occasional addition of a few pints of good vinegar.

After the hides have been sufficiently raised in the white dressings, they are put in the red. This latter is composed of clear water, and two or three handfuls of bark placed between each hide. The hides remain thus for three or four days, when they are again treated with the same quantity of bark as at first, and left for three days longer; after which time they are ready to be laid in the vats, in the same manner as limed hides. The red dressings impart that degree of firmness which prevents the too rapid action of the tan liquor, and the hardening of the hides.

With some slight modifications, this process is one of the best that can be followed. For example, a fresh vat may be used every two days, and thus there will be a gain of half of the time. Instead of clear water, it would be much better to use the liquor of the tan-pits, and to place between each hide a layer of coarsely ground bark for the red dressings.

We will remark that 200 pounds of bark are not sufficient for 100 hides, averaging 100 pounds each. In some places they use as much as 300 pounds; but the proper quantity depends very much upon the quality of the bark and the fineness of its powder.

The following is a method which may be well adopted by those who prepare hides with the barley dressings:—

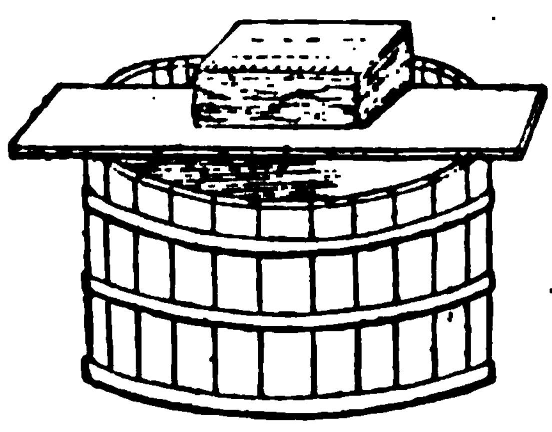
For a dressing for eight hides, averaging 50 pounds each, from 100 to 140 pounds of barley meal must be employed. Some tanners use all the meal at once; but others again make a leaven with 24 pounds of the meal, which they do not mix with the rest until twelve hours have elapsed. Many tanners keep up the acidity

of the dressings by throwing into each one three or four bottles of vinegar, at different times.

This is a very good way of increasing the acidity of the bath, and shortening the operation.

Other manufacturers, without giving themselves the trouble of making a separate leaven, put the whole of the meal in the tub, and drench it with enough tepid water to form a fermentable paste, and leave it in this state for twenty-four hours. The dressing is then made by adding to the fermented farina warm water in winter, and water of the temperature of the atmosphere in summer. The quantity of water must be regulated by the number of hides to be worked. These should be divided into two sides, before subjecting them to the dressings, wherein they must remain three weeks in summer and four in winter. To facilitate the fermentation, the hides should be taken out daily, placed on planks across the vats, as shown by Fig. 35, and there

Fig. 35.



left for two or three hours. The vats should be four feet and a quarter in height, and as much in diameter. In some countries, the tanners use nine or ten tubs, but three are sufficient; the first for the *dead* preparation, the second for the feeble one, and the third for that termed the new dressing. The only rule that can be given for depilation, is to operate as soon as the hair

can be pulled off without resistance, a condition attained frequently after the second, and even the first dressing.

The hides are then scraped, with the usual precautions, with the round knife, and are then thrown into water, in which they should not be allowed to remain more than two hours.

They are then carefully rinsed, drawn out, and placed in the second or weak preparation. If the tannery is not in the vicinity of a stream of running water, the repeated use of clean water must be substituted for soaking the hides.

The experience of the workmen must determine the length of time necessary for the weak bath. While they are attaining the requisite body, they must be taken out daily, and again replaced in the vats.

If they had not been fleshed before the dressings, it is necessary to subject them to this operation, after drawing them from the weak vat; but it is better always to do it previously. After the fleshing, they are soaked in water for two hours, then rinsed carefully, and placed in the third, which is the new dressing. It is prepared with barley meal, in the proportion of twelve pounds for each hide. A leaven is made with one-fourth of this quantity of meal, and when it begins to ferment, the residue is added, and the whole thoroughly diffused in an amount of water proportional to the number of hides to be worked.

The exact time requisite to complete the swelling of the hides, in the third dressing, cannot be determined; for it varies with the nature of the skins, the season, &c.; and must, therefore, be regulated by the judgment of the workman.

The hides during this, as in other dressings, should be daily removed from, and replaced in the vats.

The hides, after passing through the first three, or white dressings, are then put into the red, which is made of liquor from the tan-vats, to which must be added about forty pounds of coarse bark for every six hides.

Care must be taken, in this manipulation, to avoid delay, and not to give the bark time to subside to the bottom of the vat, for then the skins will be unequally tanned.

To prevent this, it is best to commence work with the red dressing, very early in the morning, so that the operation may be completed before night, and the necessity of leaving the skins in too long without stirring be thus avoided. By this arrangement, the hides may be taken out and replaced twice daily, once in the forenoon, and again in the afternoon. The first time, they are allowed to drain for eight to ten minutes, while the dressing is being stirred, and are then immediately replaced. The second time they are taken out, fifteen minutes are allowed for draining, and, in the interval, forty pounds of coarse bark are added, and the vat is thoroughly stirred.

The next day and the day after, the skins are taken out and put back again three times daily—at morning, noon, and evening—and left to drip an half hour each time. Twenty-five pounds of fresh bark are added in the morning only; but, upon every removal of the hides, the dressing must be carefully stirred. No bark is to be added on the fourth day; and the hides are taken out only twice, in the morning and evening, but are allowed to drain three-quarters of an hour each time. During the intervals, the vat must be stirred before the hides are put back. The last step, upon the fifth day, requires a new manipulation. After the hides, taken out in the

morning, have drained for three-quarters of an hour, two workmen on one side of the vat are engaged in stirring up the contents, while two others put back the hides, flesh sides down, care being taken to spread some handfuls of bark upon each. When the vat is full, the last skin is put in, reversed, with the hair side down, and some bark is sprinkled over it. After ten days, the hides are taken out, rinsed in water which has been used for a dressing, and laid in the vats. This is termed the *coloring*. About fifty pounds of coarse bark are generally consumed in the last dressing.

The red dressing is a very important step in the process of tanning. It gives firmness to the hide, by an incipient tanning, which serves as preliminary to that which is to follow. According to Delalande, a skin which has not received a red dressing, is tanned so rapidly that it shrinks, becomes hard, wrinkled, and insusceptible of perfect combination with the astringent principle of the tan. Experienced tanners aver that these faults arise rather from giving too strong a dressing, than from having the vats too strong. The *feeding* of a vat, according to Dessable, can never be too strong, for the hide neither hardens nor shrinks in the powder. We agree with him in part, but believe that a strong feeding of the vat is injurious. Experience proves that if the hide be directly subjected to contact with a concentrated liquor of bark, the operation of the tannin is very active, but its combination with the gelatine is so rapid upon the exterior surfaces, that the interior is unacted upon, as is the case in hasty tanning, where processes like that of Seguin are followed.

The red dressing is, therefore, a primary degree of tanning, which should be succeeded by the stronger ones. The hides, consequently, are to be placed immediately

in the vats, in the same manner as limed hides. It is well to add, that there is no necessity of covering the red dressings, but they must be kept filled to within two inches of the top of the tubs.

There are some tanners who contend that barley-dressed hides require about 20 per cent. more bark than those which have been limed. In many tanneries, they take for a barley-dressed hide, averaging 100 pounds in weight, 224 pounds of bark, as follows: 84 pounds for the first, 74 pounds for the second, and 66 pounds for the third.

The same results are to be obtained with rye flour; but that grain being expensive, barley is substituted for it.

The descriptions of these various dressings have been given more for the purpose of making known the processes employed in different countries, than of recommending them to manufacturers. Their use is now very generally abandoned, in consequence of the uncertainty of their action, and the injurious effects which atmospheric changes exert upon them. We accordingly proceed to the consideration of more advantageous and commonly used methods of procedure.

Raising by Sour Tan-liquor.—This method of depriving skins of hair, and *raising* them by the action of tan-liquor, was first practised in Germany, but has since been adopted and generally resorted to in many parts of France.

Its use presents more difficulties than other processes, but may be regarded as advantageous in the extreme, since it is actually the commencement of the main tanning operations, and serves to abridge the time occupied by them; and since the leather prepared by it, is much superior in quality to that treated by liming, or by bar-

ley or rye dressing. As the various processes of this method cannot be too well known, we propose to describe them minutely and fully, commencing with the account of those originally employed.

The first process we shall describe, is extracted from a memoir by Champion.

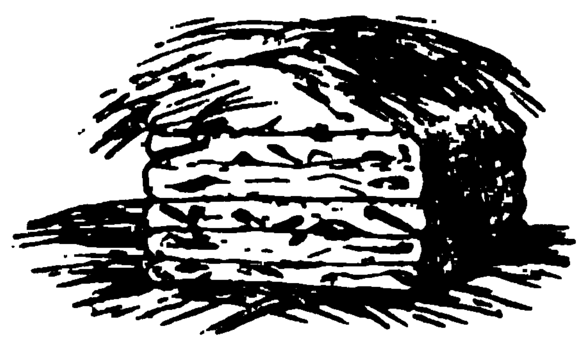
When this method was first employed in France, the skins were deprived of hair by the action of heat, and in order to prevent putrefaction, from one pound to a pound and a half of salt were sprinkled over one-half of the surface of each skin, the other half being turned over upon it, and the edges brought together so as to prevent the escape of the salt. From 15 to 20 skins were salted in this manner and placed one above the other; being left in this position during four or five hours in spring and autumn, and seven or eight in winter, the operation never being conducted in summer. At the end of this time, the skins were folded again in the opposite directions, the bellies being placed upon the backs, and the heads under the tails, and the whole being piled upon one another so as to be exposed equally to heat.

The skins were first dried with the hair on, and were then soaked for eight hours in running water; were beaten with the feet or the mace, and again soaked during four or five hours. They were then beaten a second time, rinsed, and drained upon the horse, after which they were salted as before described. After being freed from hair by the influence of heat, to which they were exposed in a tight, vaulted apartment, they were soaked in running water.

After these preparatory processes, the skins were then subjected to the steeping in sour tan-liquor, which softens and enlarges the fibre, opens the pores, and *raises* them sufficiently to receive the first tanning.

Another method is to deprive the skins of hair, by stacking them in heaps (Fig. 36), and promoting warmth

Fig. 36.



by covering them with straw or manure, their position being changed every day, until the hair is ready to be removed. If it comes off with difficulty upon the horse, its separation is facilitated by the use of sand spread upon the hair side. This method of removing the hair, however, is the most disadvantageous of any employed, as the skins are very apt to be injured by it.

In order to prepare the tan liquor for the baths, the bark which has been used for the second or third set of vats in the tanyard, is deposited in a vat, so arranged that the liquor percolating through it may be received in a draining-well or vessel placed under it, from which it can be returned into the main receptacle again and again, so as to secure an increase of strength by repeated filtrations and solutions. This liquor, when of the proper strength, should be of a clear red color, and of an acid taste like that of good vinegar, and from this a number of baths may be made of different strengths. For instance, a series of eight baths may be made, the first one containing one part of the liquor and seven of water, and so on until the full strength is arrived at.

When the skins are freed from hair, washed, and fleshed, they are soaked in clear water, for two days in summer, and four or five in winter, the water being changed every day, and the skins left to drain during

three hours. When the skins are ready for *raising*, after being steeped, they are deposited in vats containing the infusions of spent tan, being first placed in the weakest. During their sojourn in these, they are taken out every morning and evening, and allowed to drain over the vats during three hours. Towards the end of the procéeding, when in the stronger infusions, a removal from the vats once a day is sufficient.

The baths of the English tanners have less acidity than those employed in France, as they use infusions of fresh bark in clear water. They work with a large number of baths, increasing gradually in strength; and with vats of sufficient capacity for fifteen or twenty skins.

The best of all the methods originally used for this purpose in France, is that described by Delalande as the one long pursued at St. Germain. In this process, a series of twelve infusions is used, of which the ten first consist of old infusions of tan, which had been before used, and the two last of fresh tan-liquor. The skins, a dozen of which are operated on at a time, when scraped and washed, are deposited in the first or weakest bath, made only slightly sour; are taken from it at the end of twenty-four hours, and after being allowed to drain during half an hour, are deposited in the next stronger infusion of the series, and so on, being changed every day until they have been treated in the tenth vat, or the last of the old tan-liquors. The eleventh infusion, or the first of the fresh tan-liquors, consists of sour liquor, to which twenty-two pounds of coarse tan have been added for each skin to be worked in it. The skins remain ten days in this vat, and are then changed to the twelfth of the series, which contains the same proportionate amount of coarse bark as the other, but mixed with a stronger liquor. After being allowed to soak for ten days in this,

they are ready for the tanning proper, and are removed at once to the pit. An elevated temperature is very injurious to the weakest of these infusions, and when the operation is conducted in summer, care should be taken to exclude the heat as much as possible from the room containing the vats.

The sour liquor of the manufactories at St. Germain, was prepared in the following manner: Five ordinary vats were made use of; the first, which we will call No. 1, being destined for the weakest, and the last, or No. 5, for the strongest infusions. The spent tan from the pit in which skins had been imbedded for the third time, was deposited in No. 5, and warm water poured upon it through a pipe or spout. The water filtering through the tan, passed into a draining-well, and was pumped out after four or five days, constituting then an amount of tan liquor, sufficient for four of the ordinary first or weak vats. The pit was again filled with water, which, after becoming tan liquor, was transferred into the vats Nos. 1 and 2, and the contents of Nos. 3 and 4 were composed of the liquor of Nos. 1 and 2, again passed through No. 5, and the infusion originally drawn from No. 5, was replaced in it. The eleventh and twelfth vats originally referred to, were made up from the contents of No. 5, and the other ten from the contents of Nos. 3 and 4, diluted in the proper manner with those of Nos. 1 and 2. The exhausted and dried tan was used for fuel.

The following method is that now pursued in France by the best tanners: The skins, after being carefully fleshed and deprived of all superfluous parts, are soaked for twenty-four hours in fresh water. When perfectly clean and well rinsed, they are deposited in the liquors by which they are to be deprived of hair and raised. These are contained in a series of eight or ten vats, made of oak, hooped with iron, and each one being three feet

eight inches in depth, and five feet five inches in diameter. Seven or eight skins are deposited in vats of this size, enough liquid being poured in to cover them completely. The skins are left to soak for twenty-four hours in the first vat, which contains the weakest liquor, and are taken out twice during that time to drain for an hour; being placed for that purpose on boards which are inclined so that the fluid dripping from them runs back into the vat. On the second day they are taken out, left to drain for an hour, and are then placed in the second vat, which contains a stronger infusion; and the same series of operations is repeated daily, until the skins have passed through all the vats. If, at the end of this time, the hair appears ready to fall off, as is usually the case, particularly in warm weather, it is removed from the skins by working them in the ordinary manner upon the horse, with the dull or round knife. In cold weather it is sometimes the case that the process has not been sufficiently completed at the end of the time mentioned, and that the skins require exposure to the strong liquors for five or ten days longer, in order that the hair may be removed from them with ease.

The skins thus deprived of hair, have not yet been *raised* sufficiently to prepare them for the tanning, and for this purpose must be exposed to the influence of four more vats of tan-liquor gradually increasing in strength. The mode of doing this is precisely the same as that described above. After having passed through these four vats, they are deposited in a vat of the size before mentioned, nearly full of strong, fresh tan-juice, which has been previously thoroughly mixed by repeated stirring, with four pounds six ounces of sulphuric acid at 65°. During the first day of their soaking in this vat, the skins are taken out twice, and left to drain for two hours.

On the second day they are removed once, being allowed to drain the same length of time, and on the morning of the third day, they are changed to the last *raising* vat, which contains the strongest tan-liquor that can be procured, previously well mixed as before, with four pounds six ounces of sulphuric acid. On the evening of that day they are taken out to drain for an hour, and are replaced in the vat; and the next day and day after that, are again taken out, exposed to drain for the same length of time, and deposited again in the liquor. Three hours after the last draining, they are finally removed and are then found to be properly raised and ready for tanning. In this, as in the preceding processes, if the weather is so cold as to retard the raising, the skins may be kept for two days instead of one in each of the vats. The flesh side should always be placed upwards in the vats.

Quite as many and various processes for treating skins with tan-liquor have been devised, as for the use of barley dressings, but we will content ourselves with the description of two which seem to merit notice.

In the first of these, three vats are sufficient, and the skins are exposed to five infusions. The first is weak, being composed of four bucketfuls of tan, and five of water, and is not prepared until it is required for use. The skins, after being softened, dipped, and rinsed, are steeped in this for twenty-four hours, being taken out to drain for a quarter of an hour, three times during the day. They are then deposited and treated in the same manner in the contents of the second vat, which has been prepared four or five days beforehand, and consist of six bucketfuls of tan, mixed with one-fourth of tan-liquor and three-fourths of water. On the third day, they are placed in a vat containing six bucketfuls of

tan, mixed with equal parts of tan-liquor and water. At the end of two days, the skins are then put to soak in a liquor composed of the contents of the last vat, mixed with sour liquor from the draining-well. They remain for five days in this, being taken out and drained as before. On the first day, 40 pounds of coarse bark, for every six skins, are added to the mixture; and, on the second, third, and fourth days, 22 pounds for the same number, are mixed with it; the skins being only removed to drain twice on the fourth day. On the fifth day, they are taken out once to drain for a quarter of an hour, are replaced, and well powdered over with about 40 pounds of coarse bark for every six skins. After being left in this mixture for eight or nine hours, they are removed, and placed in the fifth and last liquor, which consists of a mixture of strong, fresh infusion, and of sour liquor. They are left in this for three days, being taken out to drain each morning and evening, and 12 pounds of coarse bark being thrown in every day. On the morning of the fourth day, they are taken out and drained for three-quarters of an hour, during which time the liquor is well stirred by workmen; after which, they are returned to the vat, a large quantity of spent or coarse bark being thrown upon each skin as it is put in. The skins remain in this state eight days, when this part of the process is concluded.

When the skins have been taken from the first vat, its contents, being very weak and exhausted, may be thrown away; and the second infusion, when used, may be poured into it to supply its place for another operation; and so on to the last vat, the contents of the stronger one being poured, when once used, into the vat next behind it in the series.

The other method of treating skins with tan-liquor

has already been partially described in the account of that pursued at St. Germains. In most tanneries, a series of eight vats is used in summer, and one of twelve in winter; in the first case, the weakest infusion, consisting of one part of strong tan-liquor to seven of water; the next strongest, of two of liquor and six of water; and so on to the eighth, which consists of tan-juice unmixed.

In spring and in autumn the skins are made to pass through ten vats, the first containing one part of liquor and nine of water, and the last, the strong infusion. In winter, the weakest consists of one part of liquor to eleven of water, and so on. In summer, the skins are taken out and left to drain, during an hour, twice a day, on the first three days; and, in winter, as often on the first five days. Until the seventh day in summer and the eleventh in winter, they are taken out daily, to drain for two hours; and at the end of the seventh day in summer, and the eleventh in winter, they are removed, left to drain during two or three hours, and are then replaced in the vat, each skin being liberally sprinkled with coarse tan. They remain, for three or four days without being disturbed, in the vats, which, in either case, are the next to the last, and are then removed to the last vats, which contain undiluted tan-liquor; and, after being steeped in them for six or eight days, are ready to be transferred to the pits. As cold retards or prevents the fermentation of the materials and the success of the process, the time of exposure may be still further extended in winter, or the contents of the vats may be kept moderately warm by the aid of artificial heat.

Many other slight variations from these processes have been resorted to by different manufacturers. But since

the quantity of acid necessary to *raise* the skins has been determined by Seguin, the most important operations of the method by tan-liquor have been conducted with uniformity. The adherents of the old modes of separating hair and *raising* skins have opposed many objections to these processes, on account of their difficulty, and the care and nice management required in their use; but there can be no doubt of their advantages, and of the very superior quality of the leather manufactured by them.

Preparation of the Tan-liquor.—The tan-liquors used in the processes we have been describing, are obtained by the filtration of water through the partially exhausted bark of the second and third series of vats in the tan-yard, and derive from it their astringent and acid properties. This tan, after remaining for a time in contact with the skins in the vat, loses and gives up to them the greater portion of its tanning ingredients, and then is readily disposed to ferment and acidify; still retaining, however, some of its tanning properties, but becoming more and more acid as these are removed from it by absorption into the tissues of the skins. These qualities are calculated to injure the leather, and make its removal from the vats necessary before it has been too long exposed to the action of the exhausted and acidified tan.

For the purpose of procuring the sour liquor, then, the tan from the second or third series of pits, from which the leather has been removed, is deposited in an empty vat, in which a draining-well, or chimney, composed of oak planks tightly joined together, has been erected. Fig. 37. This well is so arranged that the fluid can only enter it from below; and a pump adapted to it, serves to withdraw its contents; or they may be removed in a

bucket (Fig. 38). The vat is then filled with water, and the solution formed by its filtration through the

Fig. 37.

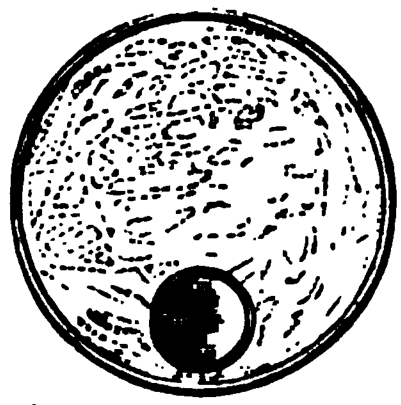
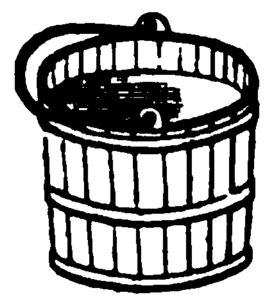


Fig. 38.



tan, is raised, after a few days, from the well, and is again poured over the surface. This proceeding is repeated again and again, until the tan is entirely exhausted of its soluble contents. The top of the vat should be kept closed, so as to prevent loss of fluid by evaporation. In place of this method, a number of vats may be filled with the spent tan, and the solution taken from one of the series may be made to pass through a second, a third, or more, until sufficiently saturated. From fifteen days to a month are usually required to give the liquors the proper degree of strength and acidity.

The mode described above of withdrawing the liquor from the pits, is much the most convenient; but in small establishments, where great economy is practised, a vat may be kept filled with tan and water for three weeks, and the liquor may then be removed by making a hole in the centre of the pit, and taking out the fluid collecting in it, with a bucket. This liquor should again be poured over the surface, and the same process be repeated, until it is found to be of the requisite strength; when it may be clarified for use, by pouring it through a close wicker basket, which will retain the floating particles of tan. The infusion is known to be of the proper strength,

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when it has a clear, light-red color, and a taste slightly less acid than that of common good vinegar.

After the tan has been nearly exhausted by the solution of its ingredients in the first liquor obtained from it, fresh water may be repeatedly passed through it in the same way as before, and the resulting liquid may be employed either alone, for the weaker baths, or for mixing with the infusion first obtained.

Raising by Yeast.—Yeast, like other substances which pass into acetous fermentation, has the property of raising skins, and has been used for the purpose. It is mixed in a vat with warm water, the vat is covered, and fermentation takes place. When this is fully established, a quantity of salt is thrown in, and the skins are deposited in the vat, the contents of which are then treated precisely as in the case of barley dressings. The operation can be conducted in the cold, but is much more rapid and successful if the temperature of the liquor be kept elevated.*

WORKING ON THE BEAM.

After the skins have been prepared for the separation of the hair upon them by any one of the numerous methods which have been described, the next proceeding is

* As many of the processes for swelling, or raising the hides, described in this Chapter, are not in use in the United States, a nearly literal translation is retained of the parts of the French work which contain them, along with the editorial "We," which, as in some other instances, will be understood from the context, not to express the opinion of the American editor. These and other parts of the book were translated, before the necessity of the numerous changes and additions since made was evident; and it has been thought proper to present them in their original form.

to remove it entirely, by working them upon the beam. For this purpose the workman makes a kind of pad of two or three folded skins, which he places upon the horse, and over which the skin to be operated upon is laid with the hair side up; and he then scrapes the surface strongly from above downwards, with the *scraper*. After the hair is completely removed, the skin is washed and soaked in a trough, or vat full of water, and is then subjected to the following operations:—

1. The flesh and other parts not properly belonging to the skin, are removed with a sharp knife called the *flesher*, and the skin is again washed and soaked in fresh water.

2. The projecting filaments or shreds, and those parts of the borders of the skin which are thicker than the rest, are cut off with a sharp knife, and the skin is again immersed in fresh water. The portions thus removed may be set aside for the use of manufacturers of glue.

3. The hair side is then well rubbed and smoothed down with a stone, similar to that used for sharpening the knife-blades, but which is set in a wooden handle. This done, the skin is dipped for the third time in fresh water.

4. Both sides are well scraped and smoothed with a knife having a curved blade, so as to equalize the surfaces and remove all foreign particles.

A dozen skins can be worked in this way by one man in the course of a day.

CHAPTER XIV.

TANNING PROCESS.

Having completed the consideration of the various operations to which skins are subjected before they are prepared for tanning, we proceed to give an account of the latter process, commencing with a description of the pits or vats in which it is conducted.

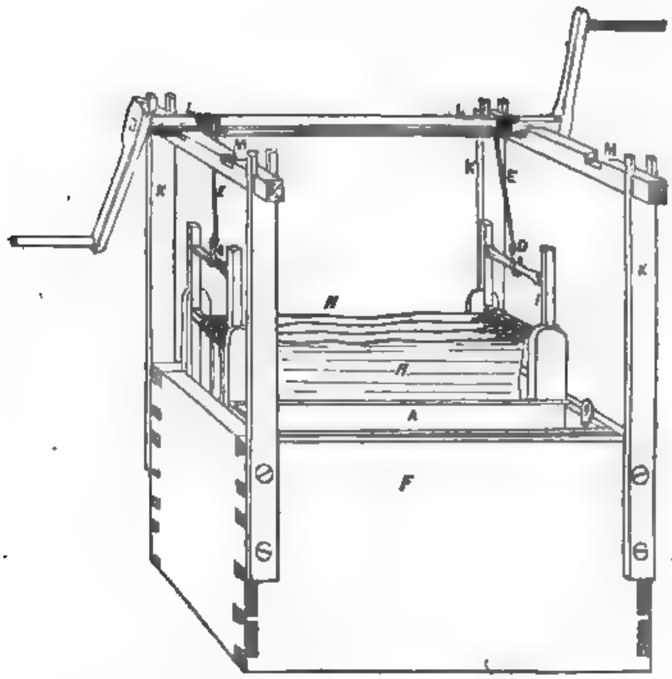
TAN VATS.

Some of these consist of large, square holes, excavated in the ground, about six and a half feet deep, and eight feet across, and lined with masonry and hydraulic cement.

At Paris, and many other places, however, they consist of strong cylindrical, open, iron-bound, oak-wood vats, covered externally with pitch, and sunk into the ground. These are less liable to leak than those before mentioned; and not having, in their construction, any lime or other material which, by chemical action upon the tan liquor or skins, might impair the quality of the leather, are far superior to them. These advantages have caused their general adoption. There is, however, another form of vat, recently invented and patented by T. W. Brown, of Virginia, and shown in perspective by Fig. 39. This view also exhibits the movable bark

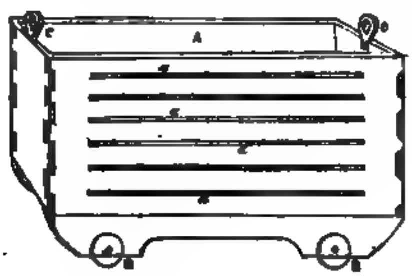
chamber contained in the vat; the hide frame and windlass for moving them.

Fig. 39.



"Figure 40 is a perspective view of a locomotive bark chamber detached from the vat. Similar letters in the figures refer to corresponding parts.

Fig. 40.



"The invention and improvement consist in the employment of a rectangular chamber A, for containing the bark, mounted upon four wheels B, by which it is moved to and from the vat, and provided with two loops *c*, to receive the hooks D of the windlass chain E, for raising and lowering the said bark chamber A in the vat, one side and the bottom containing a number of parallel slits *a*, to allow the liquor to run through, and not the bark; the use of the said rising and falling, and locomotive chamber A, in combination with the ordinary vat F, affording to the tanner a convenient mode of managing the bark, and enabling him to extract the greatest amount of tanning properties from it, and to draw and handle the bark as well as the hides, which is a very important part of the tanning process, and to empty and supply the vat of bark with great facility, the wheels not only serving to facilitate the operation of transportation of the bark chamber, but to prevent its bottom from touching the bottom of the main vat F, when lowered into it, and then allowing a free passage for the liquor to circulate, and the slits in the side and bottom of the bark chamber permitting the liquor to run freely through the bark and out of the chamber as the latter is raised; and again to run into it and to circulate through the bark when the chamber is again lowered into the vat F; and by a repetition of these operations, to extract the tanning properties from the bark most effectually; this mode of handling the bark in the process of tanning leather being entirely new, the bark heretofore having remained at the bottom of the vat in a compact mass, preventing a change in its position and a free circulation of the water, and consequently a proper extraction of the tanning properties from the bark, and much difficulty in removing it whilst changing the bark. The strongest liquor would also re-

main at the bottom of the vat. My improved bark chamber will permit the strongest liquor to percolate through the bark and bottom of the chamber, and pass thence into the part of the vat containing the hides, and when the chamber is raised to a higher level, the liquor will pass into the vat amongst the hides, at a higher level."

"The hides H are suspended to a rising and falling frame I, placed in the same vat that receives the aforesaid chamber, being raised and lowered by the same windlass L that raises and lowers the bark chamber. K is the frame that sustains the windlass. L is the windlass. M are the bearings in the frame to receive the windlass when the latter is applied to the raising and lowering of the bark chamber."

In the common vats, after the skins have undergone all the preparatory processes, they are cut in half and stratified along with tan in the following manner:—

The bottom of the vat is first covered to the height of six or seven inches with spent bark, and over this substratum, a layer of fresh bark, an inch or more thick, and well moistened and pressed down, is spread. A skin is then placed on top of this layer of bark, then another stratum of fresh bark, and so on, alternately a skin and bark until the vat is full.

Each intervening stratum of bark must be an inch deep, and always moistened like the first; and it should be equally spread over the surface of the hide.

Many tanners use the dry powder as it comes from the mill, but it is worked with much difficulty when in that state, and the laborers are exposed to the danger of inhaling the dust which is constantly rising from it. A much safer and more convenient method is to moisten it outside of the vats, as, when in the humid state, it may

with great ease be thrown upon the skins and spread out upon them with a shovel.

When the skins have all been imbedded in the tan, they are to be covered with a six inch stratum of bark, technically termed the *hat*, which must be distributed uniformly over the surface, pressed down by the feet, and covered with boards.

In small tanneries the pits are not always filled on the same day, and frequently only a small number of hides are placed in them at a time. As it is essential in these cases that they should be kept fully moistened, more water should be added each time that the new skins are deposited in them; and in order that the relative position of the contents may not be disturbed, the surface should be covered with a coarse cloth, and the water carefully poured over from a watering pot, and allowed to infiltrate gradually.

The water being equally distributed throughout, and in sufficient quantity, the *hatting* of the pit is completed. In establishments where they do not commence vatting until a number of hides sufficient to fill the vats has been prepared, the watering should be completed in one operation. When this is the case, it may happen that the tan rapidly absorbs all the water poured in, and in a day or two appears to have become perfectly dry. More water should then be added, until it is certain that the vat contains enough to moisten thoroughly all the hides. The quantity required for each hide is about 12 gallons.

When, as often happens, particularly in small establishments, the tanner is compelled to place together in the same vat, hides in different states of progress, that is, those of the first, second, and third treatment, the following mode of arranging them must be resorted to. Those of the third treatment are to be deposited at the

bottom; those of the second, above them in the middle; and those of the first on top; so that, when those which have gone through the three treatments are taken out to dry, those of the second may occupy their place at the bottom, those which were before at the surface being in the middle, and the fresh hides, which are to be subjected to their first treatment, being placed at the top. This convenient method promotes an equalization of the tanning, and should always be adopted; because the *continued* exposure of the same set of hides to those parts of the vat which possess the greatest tanning power, and of others to the upper strata of bark which contain the least, is thus avoided. The substances at the bottom of the vat, undoubtedly, are those which possess the strongest tanning powers, because the descending infusion, passing through the layers of tan above, becomes more fully impregnated with tannin and extractive matter than that portion which remains in contact with the upper strata of solid materials. Moreover, the complete penetration and combination of these matters with the fibrine and gelatine of the skins is promoted by the pressure of the superincumbent hides, the tan, and the column of fluid.

When the ordinary arrangement is adopted, it is customary in filling the second vat, to place at its bottom those hides which have been at the top of the first, and so on throughout the ranges of vats. This is done for the purpose of promoting a uniform impregnation of all the hides; since, if always kept in the same position in their progress through the yard, those occupying the lowest one would be the most thoroughly charged with tannin.

As oak bark is variable in quality, it is scarcely possible to give, with certainty, any proportion which it should

bear to the skins. Skins weighing 110 pounds usually require, however, about double that amount of bark. From 33 to 44 pounds usually suffice for each of the skins from Brescia, which do not commonly weigh more than 26 pounds. Weak, thin and poor, or dry hides, being of inferior quality, require very little bark, and scarcely acquire any increase of substance. Common hides scarcely ever need exposure to more than three treatments; the first being given upon the grain, and the others upon the flesh sides. The finest powder is used for the first process, which should occupy three months. Coarser stuff is employed for the second, which should take four months, while the *coarse bark* alone is sufficient for the third exposure, occupying five months. This length of time may be considered sufficient for tanning, though the best tanners extend it, giving to their hides four, or, for the best qualities, even five exposures in the pits.

Fresh hides, of course, exhaust the tanning ingredients to which they are exposed in the first process much more rapidly than they do in the subsequent ones; and hence the necessity of a longer treatment in the second and third vats than in the first. After they have been thoroughly *fed* in the first, further contact with the spent materials would be useless, as these are almost entirely deprived of activity; and it may be very injurious to them by promoting putrefaction. In passing through the last vats, however, they run no such risk; for, being in contact with strong solution of bark, they are still constantly—though from the resistance of their already tanned surfaces, gradually—absorbing tannin, and acquiring density. Small portions of alum are added to the tan by some manufacturers, with the intention of diminishing the impermeability of these tanned surfaces, and

hastening the process in its latter stages. The practice is, however, neither a common nor a desirable one.

In changing hides from one pit to another, care should be taken to remove from their surfaces all the spent tan which covers them, so that there may be no mixture of effete matter with the fresh bark. Some tanners even take the trouble of beating and shaking the hides each time that they are changed.

The importance of discovering some process which would shorten the time usually occupied in tanning, without injuring the beauty and durability of the leather, and which would also diminish the expense of the manufacture by substituting some less costly materials for oak-bark, has long been appreciated by chemists and practical men. Among others who have devoted much attention to this subject is Seguin, who, acting upon his opinion that the combination of tannin with the gelatine and fibrine of skins might be much accelerated by presenting it to them in a liquid and concentrated form, succeeded in greatly shortening the time required for tanning. But experience has shown that, though the leather prepared by such means is, to all appearances, well tanned, it does not possess the requisite qualities. It is not thoroughly and uniformly impregnated; for, while the outer layers of the two surfaces combine rapidly with tannin, a deposit of gallic acid and extractive matter forms a compact coating, which prevents their complete penetration, and renders their interior inaccessible to the liquid. This leather is dry and by no means durable, its interior consisting of untanned hide. An account will be given, in its proper place, of the processes of Seguin and his followers.

Experience has shown that, to insure the perfection of leather, all the gelatine and fibrine of the original

skins must be made to combine with tannin; and that this combination must be effected in the most gradual way, the accomplishment of which is only to be procured by exposure to solutions which at first are weak, and afterwards are increased in strength, until at last complete saturation is arrived at. After this entire conversion of substance has been attained, further exposure only serves to injure the texture of the hides by introducing into it a dry, hard, and horny matter, which renders them brittle, and easily penetrable by moisture, and to consume uselessly the time and money of the manufacturer. If, on the contrary, they have been exposed too short a time, they will be imperfect and wanting in the requisite weight and solidity. It is, therefore, an established fact that twelve or eighteen months are required for the complete tanning of the best qualities of hides, they being found to increase in strength and weight up to the end of that time, which is the usual duration of the process in England as well as in this country. Still, there as well as here, skins are often sent into the market after an exposure of six or ten months, or even less time.

Dessables's Process.—Dessables reports the following process—which we give in his own words, without indorsing his views—as being one which much shortens the length of time required in tanning.

"A draining-well is to be erected in one corner of the pit, by means of two planks properly adjusted, and to this a pump is to be adapted. The liquid which filters through the tan will then accumulate in the well, and can be distributed over the surface of the pit two or three times a week, by means of the pump. These repeated washings will be a certain means of extracting from the tan all its soluble parts, and of keeping the

hides always soft, and in a condition to be thoroughly moistened and penetrated in every direction. The proper time for discontinuing these filtrations and refiltrations can be easily ascertained, and is doubtless much earlier than in the ordinary methods."

It is supposed by some that alum would assist in rendering leather more firm and durable, and that if any substance as astringent as it is, and cheaper than oak-bark, could be obtained, the time taken up by the tanning process would be much abridged. This substance, however, is not sufficiently cheap to be used in large quantities, and experience has not yet shown that it possesses the properties attributed to it.

Herapath and Cox's Process.—Herapath and Cox, of England, have devised a quick process of tanning, which consists in passing the hides between two horizontal rollers, driven by steam, once or twice daily, while being handled in the tan vats. This treatment expresses the spent liquor, which, if allowed to remain in the hide after having become exhausted by it, would impede the tanning power of fresh ooze. The action of the rollers, therefore, in the intervals between the usual transfers from the weaker to the stronger vats, by driving out the impoverished liquor, predisposes the hides to a more rapid and thorough absorption of tannin than could possibly be the case if they were passed from one vat to another while saturated with exhausted liquor.

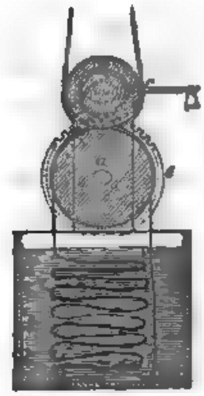
The lower roller should be about thirty inches in diameter, and covered with hair cloth; and the upper one only eighteen inches, and with a woollen envelop. The pressure must be moderate, else the quality of the leather will be impaired by too great condensation of the tissue. The hides are strung together with twine, and drawn through continuously.

Butts may be tanned by this method in four months, and kips and skins in as many weeks.

The skins must be connected together butt to butt and shoulder to shoulder, as shown in Fig. 41.

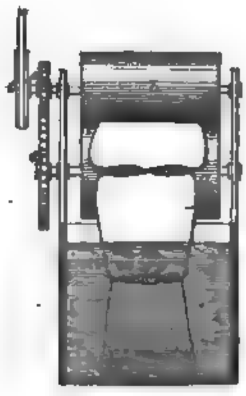
Fig. 41.

Fig. 42.



"One end of the band of skins is passed between the two rollers *a* and *b* of the tanning apparatus. (Figs. 42 and 43; Fig. 42 being a section and Fig. 43 a front view

Fig. 43.



of the apparatus.) The end having been passed between the rollers, it is to be attached to the other end of the band

of skins, and thus forms an endless band. Rotary motion is then communicated to the apparatus from a steam-engine, by means of the drum *c*, which is mounted on the axle of the roller *b*. A small pinion *d* is also mounted on the same axle, and takes into a toothed-wheel *e* on the axis of the lower roller *a*. Upon actuating the apparatus, the skins (which have been previously arranged in the tan pit) are passed between the two rollers, the upper one of which is weighted. The exhausted, or partially exhausted tanning liquor thereby becomes expressed; and, when the skin passes onward from the rollers, it again enters the pit and absorbs a quantity of fresh tannin."

CROP LEATHER.

The name is applied to leather made from the skins of cows or small oxen; the former being very eligible for the purpose, provided they possess sufficient thickness, as their tissue is more compact than that of ox-hides; at least, if they have not already calved. The skins of young oxen are deficient in firmness and thickness, and are only used for conversion into belt leather.

This sort of leather requires a much more thorough currying than thick hides, which are almost fit for use when taken from the tanning. It is employed principally by shoemakers for second soles, and uppers for women's shoes and men's light shoes and pumps. Young ox-hides are regarded by shoemakers as inferior to cow-skins, and they use the latter for the upper and thin soles. The tanning of these hides is conducted in a somewhat different way from that of thick hides.

They are placed first in the lime-pits, and, when ready for depilation, which is usually in eight days during summer, and ten or twelve in winter, are repeatedly

fleshed and scraped, care being taken to rinse them each time, in clean and running water if possible, so as to remove all the lime. Those intended for uppers require at least four or five rinsings, while two will suffice for those which are to be used as soles.

They are then deposited in wooden vats, four feet four inches in height and six feet and a half wide, which are nearly two-thirds filled with a weak ooze or infusion of oak-bark, and are handled daily.

If the hides are worked in the same vat, the strength of the ooze must be restored, as rapidly as exhausted, by fresh additions of bark. When transferred to other vats, the liquor in them must be made successively stronger and stronger.

Tanners usually give the preference to this method, but skins are sometimes treated in hot ooze, prepared in vats similar to those just described, by adding hot water to bark, which is used in the proportion of five basketfuls for every twenty-four cow-skins. After being placed in the vats, the skins are repeatedly handled or moved about by the workmen. This working is frequently repeated, the skins being taken out daily to drain, and a little fresh bark being added to the vats in the interval. This manipulation is continued for four to six weeks.

Whichever of these methods is adopted, the hides are next subjected to a mixture of ground bark and strong liquor in other vats. For this purpose, the bottom of the vat is covered with a layer of fresh tan, carefully moistened, upon which a skin is spread out to its full extent; this is covered with another layer of tan, and the hides and bark are packed in alternately, till the vat is full. The top hide must have a "hat" of bark, and the contents of the vat be then drenched with ooze.

The workman should be careful to place the skins in every direction around the pit, the lengths of the con-

tiguous ones forming slight angles with each other, and to deposit tan in all the creases and doublings made by the bending of the edges. This process usually requires six weeks. Five baskets of tan are used for a dozen ordinary cow-skins, and about six for six dozen young ox-hides. The skins, having undergone this preparation, are then further exposed to two treatments in the vats in precisely the same manner. After remaining in the first pit for three months, they are taken out, and, before being transferred to the second one, are beaten or trod out for the purpose of rendering them more supple. This process—which should never be omitted in the case of skins intended for shoemakers and saddlers—having been completed, they are placed in the second and last pit. Tanners disagree about the time proper to be consumed in this final exposure, some being content with five weeks, others extending it to three months. The latter period is certainly not too long for hides which are intended for leather of the best quality.

After withdrawal from the pits, the leather is dried in the usual manner, care being taken to avoid exposure to the sun, a strong wind, or a cool and damp atmosphere, in which they might mould. They are then to be transferred to the currier, who prepares them according to the kind and quality of the leather, and the purposes for which it is intended.

Cow-skins differ very much in quality; those of the younger animals being much superior to those of cows which have frequently calved; the latter having become weak and thin by the distension to which they have been subjected. Young ox-skins, although long regarded as inferior to the better kind of cow-skins, are equally serviceable, and the two are now used indifferently by shoemakers. A distinction is, however, made between

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the bellies of the former and some of the other parts which are weaker, and are only used by them for upper soles.

The process of tanning which we have described, is the one employed in all the best establishments in Paris, but there are some Provincial tanners who vary it more or less. According to Dessables and Delalande, crop leather is made in Brittany, by the process of tanning in sacks, hereafter to be described. After having been exposed in the lime-pits for two months, and placed for seven or eight days in hot ooze and water, they are then filled with the decoction, and left for a week or more, care being taken to change their position five or six times daily. They are then unripped, placed between layers of bark, and allowed to remain untouched during eight days before being taken out and finally dried.

In Limousin, skins are limed for four days, and are then placed in the tan-pits, in which they are allowed to remain for three months.

In Dauphiny, they are limed for a fortnight, then exposed for four weeks to two different treatments with bark, and transferred to the vats, where they remain for a month and a half.

At Metz and Verdun, after having lain for eight days in old lime-pits, and as much longer in fresh ones, they are exposed to the action of ooze for a month, and subsequently to two stratifications with tan for five months longer.

At Bourges, and in different places in Berry, they are allowed to remain three months in the lime-pits and six months in the tan-vats.

Lastly, at St. Germain, cow and calf skins are passed through three old lime-pits and one fresh one, and then undergo five cleanings and rinsings. They are then beamed and relieved with the knife of all superfluities,

and worked upon the hair side with a whetstone, and when thus well softened and cleaned, are again thrown into water. After being worked for the third time upon the horse with the round knife on both sides, so as to expel the last portions of lime, they are again rinsed; and a fourth and fifth time treated in the same way. The final rinse water should come from them perfectly clear, and leave them in a proper state for the ooze bath.

Drying.—The drying of leather, however simple a process it may appear, is one which requires the utmost skill and attention on the part of the workmen, and the nicest determination of the point to which it should be carried. Skins dried too slowly and in moist situations, are liable to mould, which is greatly to their injury, while those which are dried too rapidly, or during exposure to the direct rays of the sun, become hard and brittle.

In order to prevent either of these extremes, every manufactory should have attached to it a drying-room, proportioned to its wants, in which numerous openings or windows admit a free current of air, while the leather is protected from the direct influence of solar heat.

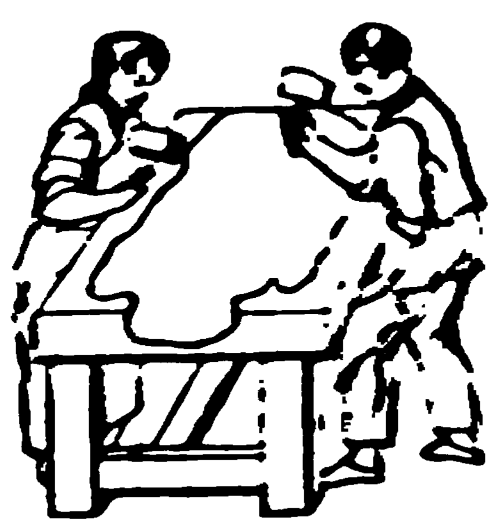
The skins when sufficiently tanned, are to be taken from the pits without being shaken or beaten, and are to be stretched on pegs or hung up by their heads from large nails, each one being kept expanded by two or three sticks, passed through from side to side, so that all parts may be uniformly exposed to the air. When they have begun to whiten and have become slightly stiff, but before they are perfectly dry, they are stretched out upon a clean place, and scoured with the spent tan with which they are still covered. When well cleaned in this way, they are then to be trod out and beaten with the soles of the feet in every direction, upon both sides; and after the inequalities and protuberances of surface have been made

to disappear by this fastening process, they are assorted in sizes and piled in uniform heaps.

While the skins are stretched in the drying-room, they should be beaten twice daily, at morning and evening, upon the flesh side, with a round-faced wooden mallet. If the skins should be dry, the operation may be facilitated by moistening their surface with a wet brush. This process imparts firmness.

After the skins have remained in piles for a day, they are exposed to the air as before for four days. When nearly dry, they are taken down and pressed under planks heavily weighted with large stones. The next day they are spread out upon an oak or marble table and beaten with an iron mallet so as to compress their tissue, and render them smooth and compact. (See Fig. 44.)

Fig. 44.



This proceeding should never be omitted, whatever may have been the original preparation of the skins for the vats. Limed hides should, however, be treated before they are dry, as otherwise the hair side surface would be exposed to the danger of being broken and rendered uneven. When they still retain a little moisture, this cannot occur.

The process of beating leather is essential to give it firmness and durability, and to make it impervious to

moisture. It is only the first step of the manipulation which the shoemaker finds it so necessary to continue upon the lapstone.

The leather, after having been thus hammered, is now thoroughly dried for the last time, and piled up in a dry and well-ventilated loft. Before it is ready for market the leather should be repeatedly shuffled, as it were; that is, the position of each hide must be changed, and the piles spread out in the manner of an open fan, and pressed, as before, under planks and superincumbent weights.

Having undergone these different processes for nearly a month, it is again piled, preparatory to being sent into the market. Not content with this management of it, some tanners even take the unnecessary trouble of storing it away in cellars for some time before they consider it thoroughly seasoned.

BEATING AND ROLLING.

Leather was originally beaten with hand-mallets, a tedious and laborious mode of operating, which, in the course of time, became obsolete by the invention of well-adapted machinery. The chief object of these machines, at first, was to accelerate the process and diminish the amount of labor; but it was afterwards found that they also accomplished the desiderata of imparting smoothness, compactness, and uniform thickness to the leather. Ignorance of their real usefulness was for a time a serious impediment to their general employment by the trade, but their intrinsic worth soon evinced itself, and they are now regarded as indispensable implements of a well-conducted tannery.

In the earlier stages of this invention, the imperfec-

tion of the machinery rendered it necessary, very frequently, to finish the beating by hand, in order to impart the requisite solidity; but improvement grew with experience, and has resulted in some comparatively perfect apparatus.

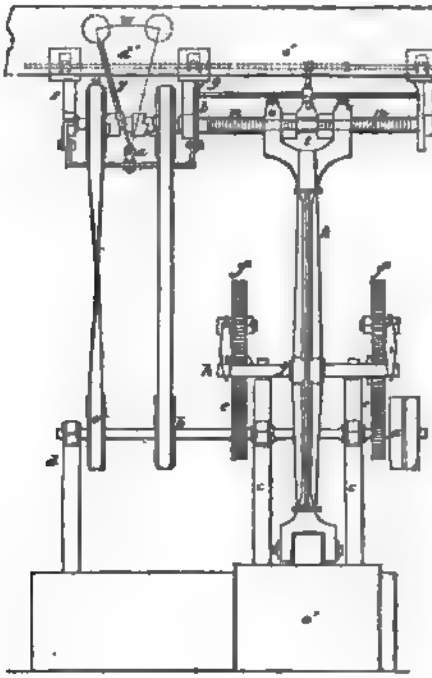
Sterlingue and Co. were the pioneers in this branch of ingenuity, and proposed the use of a hammer like those employed for forging iron, but grooved; and an anvil faced with brass. The other portions of their machine are a table for receiving the hides, and cylinders for the cords or straps which keep the leather extended, their axes being connected by an endless chain, in such a manner that the straps which are rolled upon them on one side are unrolled on the other.

The hides are allowed to be at rest during the descent of the hammer, and are moved from under it during its elevation. The blows may be increased in frequency and force at the will of the operator, and if it is thought proper to direct a number of blows upon one part of the hides, the movement can be suspended by a catch, until the required number has been applied. By these means the skin is uniformly compressed in such a manner as to render further beating by hand unnecessary.

Having found that the horizontal position of this hammer interfered somewhat with the motion of the hides, the inventors afterwards substituted a vertical hammer like a pile-driver, which they patented on the 6th of February, 1839. By this improvement they have obtained the alternate and successive action of a number of hammers upon the leather, and established a system by which rows of hammers of moderate weights are so arranged that those of the second row descend upon the prolongation of a line oblique to that of the first one, and fall upon the hides with a constantly increasing force.

Debergue's Machine.—This machine, invented in 1840, is described in vol. lvi. p. 40, plate 4, of French reports of expired patents.

Fig. 45.



Figs. 45 and 46.

a, *a*. Pulleys, for communicating movement.

b. Longitudinal iron shaft.

c, *c*. Cast framework, supporting the shafts *b* and *g*.

d. Cast support, for the end of the shaft *b*.

e, *e*. Pinions, gearing with the wheels *f*, *f*.

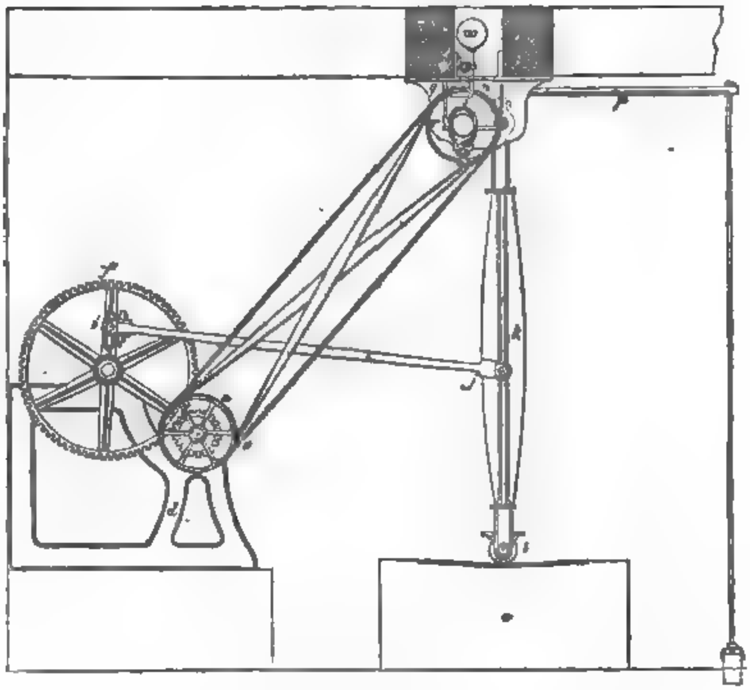
g. Iron-shaft, carrying the wheels *f*, *f*, outside of the framework.

h, *h*. Crank-rods, the iron pivots of which, *i*, *i*, are fixed by means of nuts in grooves cut in the wheels *f*, *f*, so that their position can be changed at pleasure.

j. Iron-shaft, receiving an oscillating motion from the cranks *h* and *h*.

k. Cast-iron lever, carrying at its lower extremity a stamper or small cylinder in a fork, and having passing across it the shaft *j*, the movements of which it follows.

Fig. 46.



The upper part of this lever is equally divided into two branches, in each of which is a groove traversed by the iron shaft *m*, fixed at its extremities to double cast supports *n n*. Above these grooves there are two rests, *o o*, for the cast-iron lever *p*, which pivots upon the trunnions *q q*, and to the extremity of which is attached an iron rod which supports a cast box or iron plate, or else a wooden box which can be weighted if necessary. Upon

the line marked by the rests, the lever can be moved over the whole space between the two supports, and this part should be accurately adjusted, so that, whatever may be its position, the lever will weigh uniformly upon the rests. *r*. Iron shaft, adjusted between the two supports *n n*, and resting at the other end upon a simple support *s*. The screw passes through the cast piece *t*, forming its nut, and having two projections pierced to receive the shaft *m*, upon which it moves when the screw is turned. As the projections of the nut *t* entirely fill the interval between the branches of the lever *k*, this lever must follow the movements of the nut exactly as if directly commanded by the screw. *u u* are two pulleys, across which passes the uncut part of the screw *z*. These pulleys are commanded by the other pulleys *v v*, the one by a straight strap, the other by a crossed one, and are turned in an opposite direction to each other.

x. Toothed shaft, partaking of the rotatory motion of the main shaft, which, being traversed by a pin, but being movable to the right or left at pleasure, and fitting in the claws of the pulleys *n n*, renders their movement uniform with that of the shaft. At the middle of this shaft there is a large groove, which receives two small iron stays, fixed to the interior of the oval which the lever *y* forms at its junction with the shaft. This lever is surmounted by a ball *w*, and is mounted upon an iron pivot, which is fixed upon the cross-piece *a'*, fastened at its extremities to the supports *n n*.

b'. Round iron rod having a square part at the end which slides in one of its supports, and is, by this means, prevented from being turned. This rod passes across a tail-piece, attached to the nut *t*, and carries two rings, *c' c'*, fastened at a convenient part by a compressing screw. The rod also has upon it two little projections, *d' d'*,

which engage the lever *y*, and give it an alternate motion to the right or left, when the tail of the nut encounters alternately the rings *c′ c′*.

e′. Cast, marble, or wooden table, surmounted by a copper plate. The table, as the plan shows, may be either plane or concave, without any injury to the success of the process following.*

This machine is intended to produce the most complete contraction of the pores of leather that can be attained, by means of two different movements combined in one, and by a pressure of from 18 to 20 thousand weight upon a surface of some fractions of an inch, this pressure being transmitted through the whole thickness of the skins without injuring or abrading their surfaces, and compressing those of different thickness with entire uniformity.

The hides are placed upon the table *e*; the stamper *l*, to which a round, oval, curved, or straight form can be given at pleasure, directed by the whole weight of the lever *k*; and the additional one of the lever *p*, passes over the leather and receives the oscillating motion given to the lever *k*, by the cranks *h*, *h*. It also receives another motion which makes it pass progressively across the breadth of the table, first in one direction and afterwards in the other, and which is caused by the screw which receives an alternate rotatory motion to the right and to the left, by means of the toothed shaft which catches in the pulleys to the right and to the left, being

* It will be observed that an occasional discrepancy between the lettering of the cuts and the references to them in the descriptions occurs in this and a few other instances throughout the work. The errors are to be met with in the original French treatise much more frequently than in the present edition; and those which have not been altered from the originals by the engraver, will be detected at once by any machinist.

governed by the lever with the ball on top, which is drawn away from its centre of gravity by the projections *d′*, *d′*, of the rod *b*, and falls back upon the opposite side.

The table being higher on one side than on the other, and the course of the lever passing the curved part where it is least elevated, the stamper leaves the surface of the leather at short intervals, which are determined by each revolution of the wheels *f*, *f*, and the pressure being thus taken off, the leather can be moved by the workman and replaced in another position, so that the force can be directed successively upon the whole surface.

The results of this operation are an immense economy of time, labor, and trouble, the greatest possible amount of compression and contraction of the substance of the leather, the securing of a perfectly uniform and smooth surface, and the accomplishment by one workman of what can only in common be effected by ten or twelve.

Flotard and Delbut's Machine.—The following is a description of a machine invented in 1842, by Flotard and Delbut, taken from the Reports of expired French Patents, vol. lvii. p. 86; its object being to replace hand-beating by more active means, which will be free from the inconveniences attaching to other machines. To attain this end, the inventors have endeavored chiefly:—

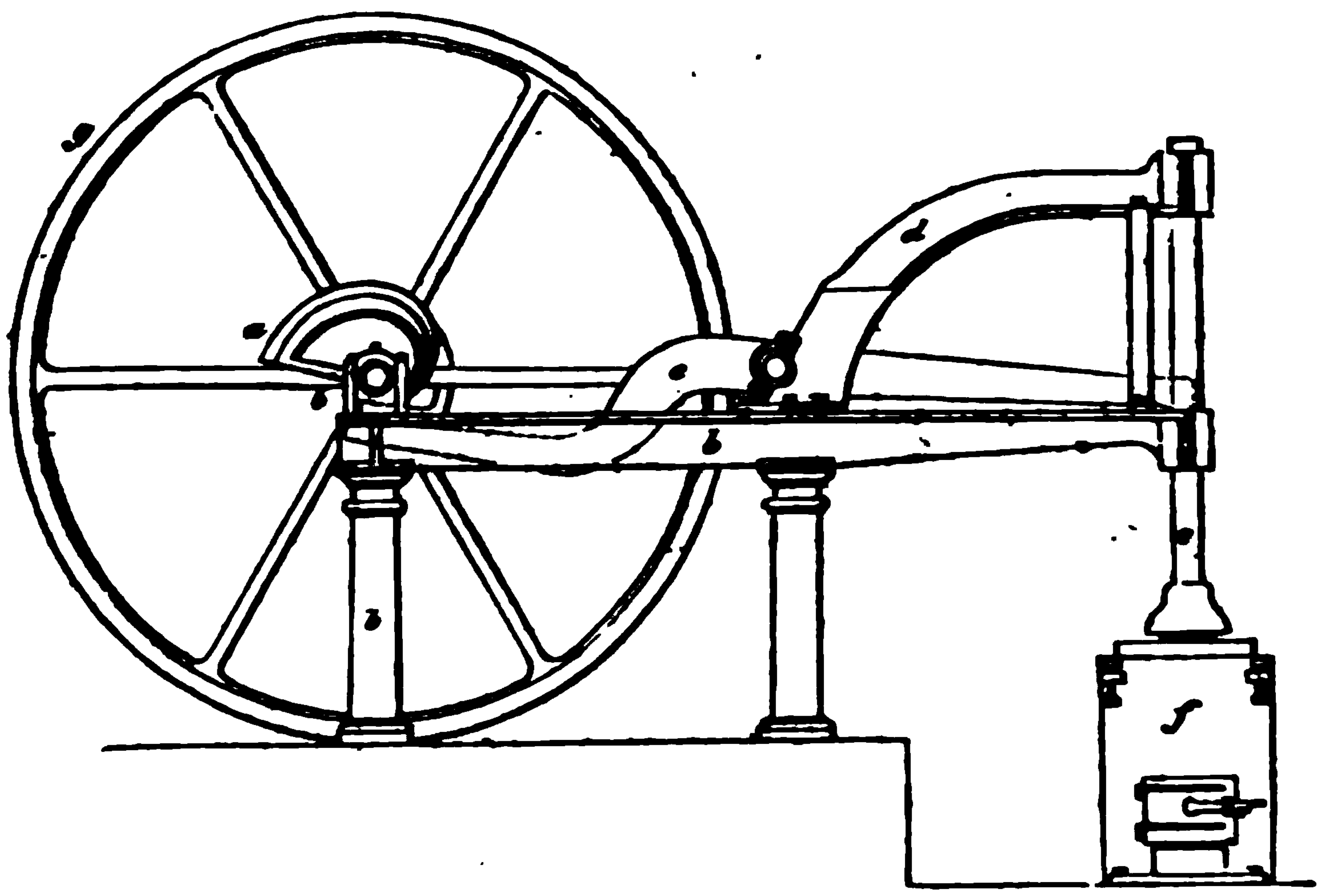
1st. To bring to perfection the construction of the mechanism moving the hammer, and

2d. To make the anvil elastic, so that injury to the leather by the hardness and roughness of the blows may be prevented.

3d. To use a table with a rolling surface, and with rollers attached to the feet.

Figs. 47, 48, and 49. *a*. Cam, intended to lower the arm of the lever *c*, so as to elevate the hammer *e*.

Fig. 47.



b. Framework, or cast beam, supported on three columns and sustaining the whole apparatus.

Fig. 48.

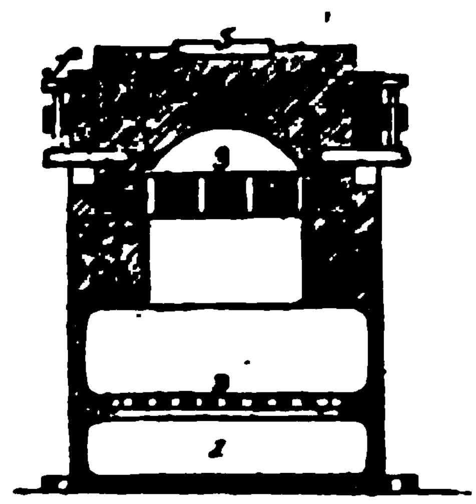
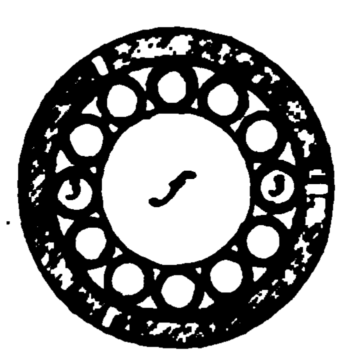


Fig. 49.



c. Lever, having one extremity furnished with a wooden cushion, and the other rounded off to enable it to move freely in the mortice of the hammer.

d. Cast arm, the end of which holds the helve of the hammer and maintains it in the vertical position.

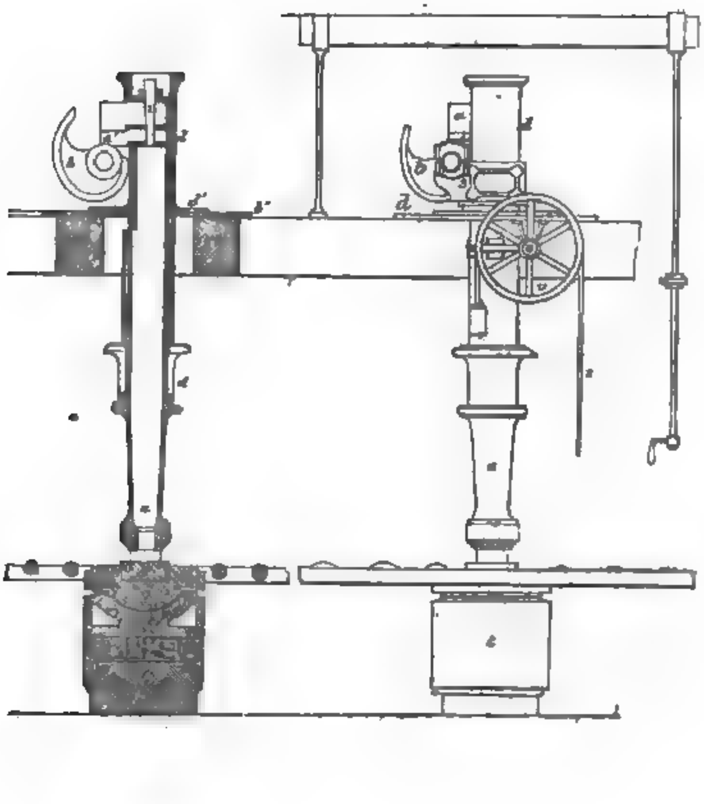
e. Hammer, having its lower surface covered with copper.

f. Support, or anvil, composed of two principal parts: the one fastened to the ground, 1, is furnished with a grating, 2, which receives the fuel, and is attached by screws to masonry-work; the other part, 4, is that which receives the impulse of the hammer. It is movable, and mounted on twelve springs, 3; and its upper surface is, like the opposing one on the hammer, composed of copper.

g. Fly-wheel, connected with the motive power by means of a band.

Figs. 50 to 53. Hammer, of cast or wrought iron. If

Fig. 50.



sufficiently small, it may be solid, but if large should be hollow.

a, *a'*. Wooden teeth, against which the cam *b* catches. These teeth are adapted to two mortices in the upper part of the hammer, and are retained in place by a wooden wedge. By means of the two teeth, the hammer can be elevated more or less, either by taking off the lower one, *a'*, or by enlarging or diminishing their size.

b. Cam, acting upon the teeth *a*, to elevate the hammer.

d. Cylinder, directing the hammer and keeping it vertical. This is furnished with two projections 3, which support cushions for the shaft of the cam *b*. It rests upon a shoulder *d'*, upon the plate *b'*. The lips *i*, *i*, against which the wooden teeth slide, prevent the hammer from turning.

Two lateral openings, *o*, *o*, Fig. 51 (also seen in Fig. 50), allow the cushions *r*, *r*, (Fig. 52) to pass, which

Fig. 51.

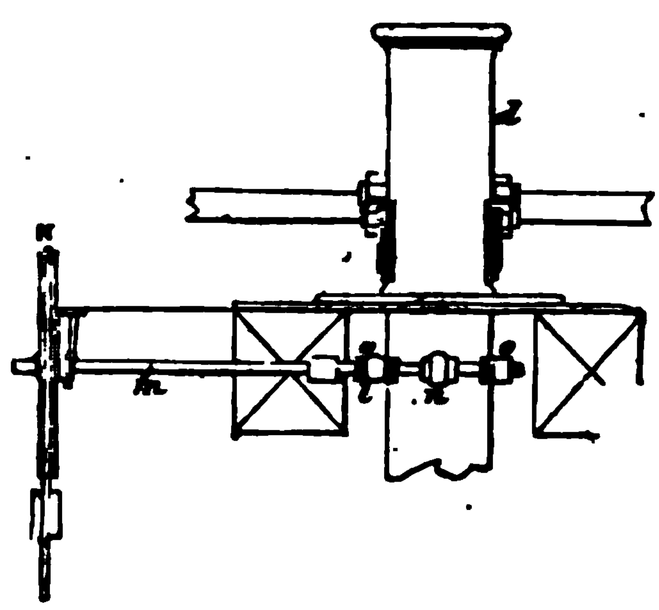
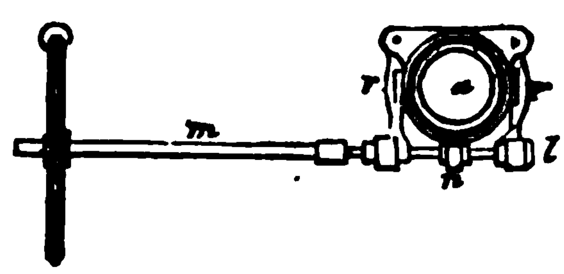


Fig. 52.



press the levers *l*, *l*; worked by a screw, to the right at one end, and to the left at the other. Fig. 51 exhibits this arrangement.

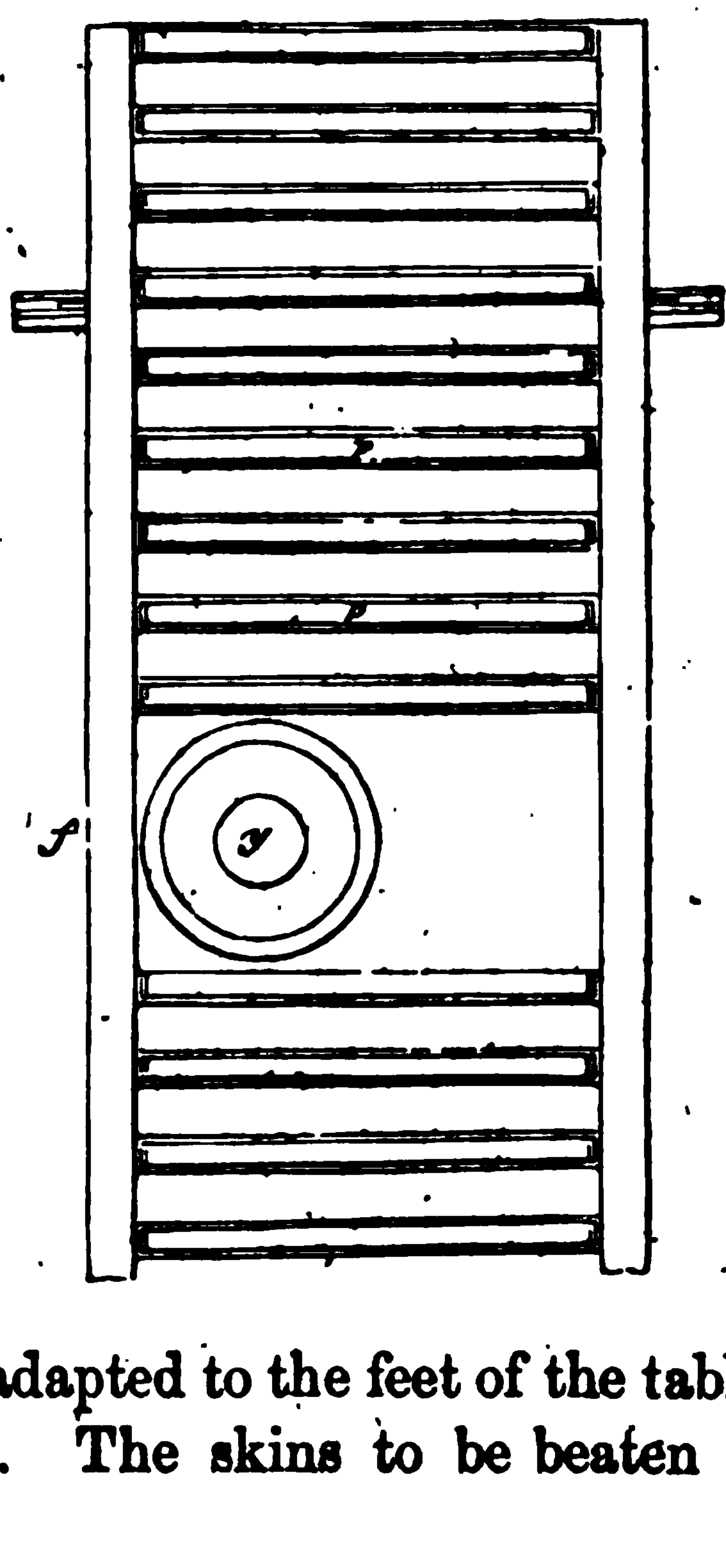
The shaft *m*, Fig. 52, serves as a prolongation of the screw *n*, Fig. 51, and carries a pulley *v*, Fig. 50, upon which passes a cord having a weight at one end, and a stirrup for the foot at the other. The cushions *r*, *r*, pro-

duce a friction which slackens the fall of the hammer, and diminishes the force of the blow.

d'. Circular plate, or cup, intended to receive the oil or grease dripping from the machinery, and which might otherwise fall upon and soil the leather. Fig. 50. Two vertical pieces, supporting horizontally a rabbit, or wooden spring, which is elevated or depressed by the screw attached to one end of it, so that the hammer *a*, in rising, touches it with more or less force, so as to augment the power of the blow. A metal spring may be used in the place of a wooden one.

f. Figs. 53 and 54. Table with rollers, *p*; its feet rest on iron rails.

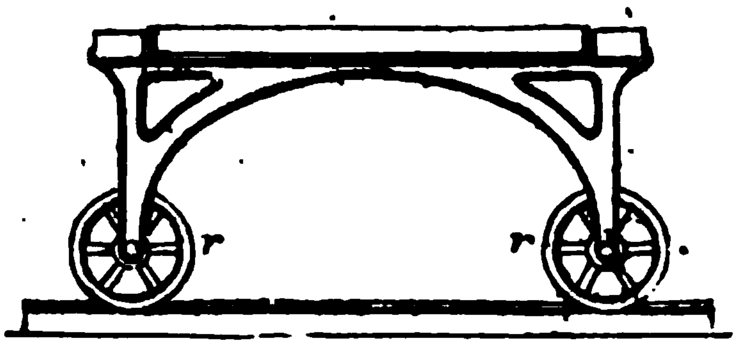
Fig. 53.



r. Wheels, adapted to the feet of the table and running upon the rails. The skins to be beaten are placed on

this table, and upon its middle the anvil, upon which the hammer descends, is supported.

Fig. 54.



The anvil is chambered for the passage of a current of steam, for the purpose of warming the copper face, *y*; and it rests upon springs, which are intended to render the shock of the hammer less severe, and to diminish the jarring.

As the system of vertical hammers has long been in common use, the invention of Flotard and Delbut consists really, only in the use of

1. The spring, for increasing the force of the blow.
2. The check, for diminishing it.
3. The cups, for receiving the oil drippings.
4. The movable table, with rollers.
5. The arrangement of springs, under the face of the anvil, and
7. In the passage of vapor.

M. Berendorf's Machine for Pressing Hides.—The following report upon and description of this machine is from the Bulletin of the Society for Encouragement of Arts, &c., of the year 1845, p. 68.

The necessity of hammering by hand skins intended for sole leather, formerly a very essential though fatiguing means of compressing them, has now been almost entirely prevented by methods which much more effectually answer the same purposes. Among these means that of M. Berendorf, which substitutes for hammering a rapidly

applied compression, somewhat analogous to it in operation, has been very successful.

The peculiarity of the mode employed by him in the use of the machine invented in 1844, consists not so much in this substitution of rapid compression for hammering, as in the peculiar arrangement of the support for the leather, which, by its elasticity, makes it possible to confine the amount of pressure to any desired limits. The support is an anvil, resting upon a spring composed of hard wood, the amount of resistance of which can be modified at pleasure by the workman, who, holding the hide by one hand, turns with the other a screw which exactly regulates the pressure to which any particular part of the leather may be exposed.

"The machine of Berendorf is powerful, and simple in all its parts. A beam acts upon a lever, the fixed point of which is attached to a cast-iron support, which forms the top of a frame large enough to receive a great number of hides, and having in its middle an opening through which the piston which produces the compression by means of a lever about to be described, slides.

"The compressing surfaces in contact with the hides, are made of brass, are smooth, convex, circular, and have a diameter of from $3\frac{1}{10}$th to $3\frac{8}{10}$th inches. The skins exposed to their action are beautifully smoothed and perfectly compressed by it.

"The advantages of this process in improving the quality and appearance of leather, and its superior cheapness, have induced the council to bestow upon M. Berendorf a silver medal, and to insert in their Bulletin this report, accompanied by a description and plate."

This machine is composed, 1st, of a movable vertical hammer, which exerts pressure upon the hides. 2d. Of

a fixed anvil, upon which they are placed. 3d. Of a lever which gives the impulse to the hammer.

Fig. 55 exhibits a front view of the machine.

Fig. 55.

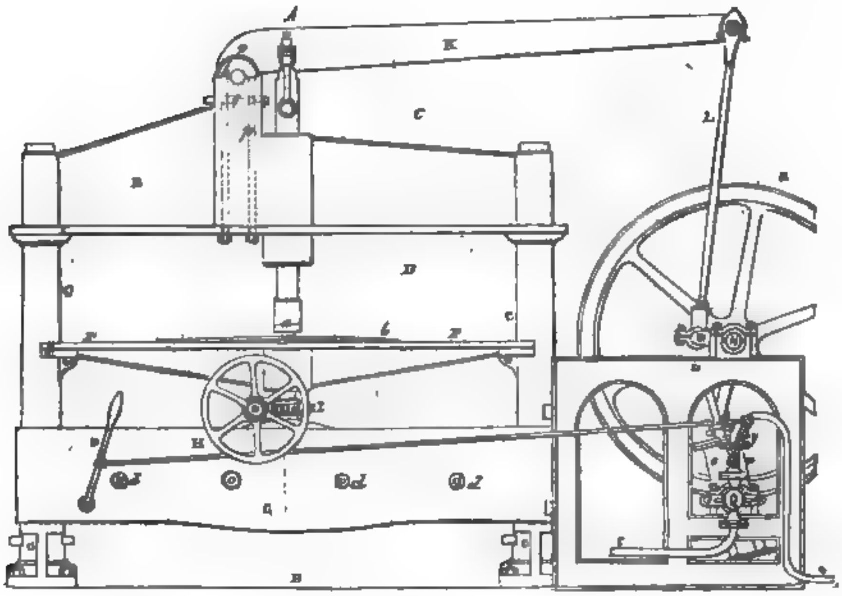


Fig. 56. A plan.

Fig. 56.

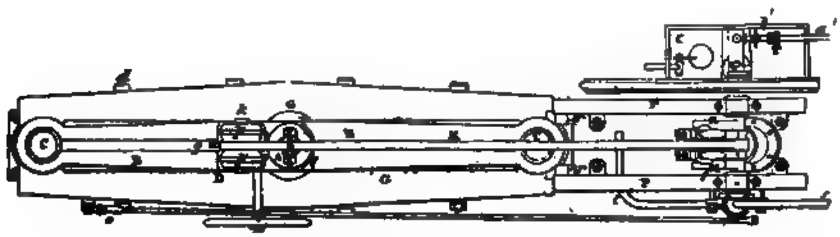


Fig. 57. Vertical and cross section, made upon the line A, B, in the first figure.

The same letters apply to all the figures.

1. The wrought-iron hammer, *A*, is furnished, at its inferior extremity, with a face of bronze, and its cylindri-

Fig. 57.

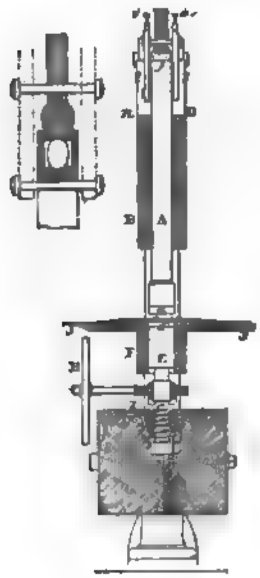


Fig. 58.

Fig. 59.

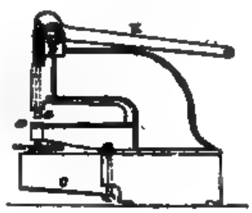


Fig. 60.

Fig. 61.

cal shank or helve passes through a vertical socket in the large and strong cast-iron beam *B*. This latter, which is represented in cross section by Fig. 58 (upon the line *C D*, Fig. 55), is strengthened by mouldings, and rests, by its extremities, upon two cast upright columns *C C*, with which it is firmly connected. The space between these uprights, amounting to but 78 inches, only admits half hides, although M. Berendorf

has also adopted another arrangement, represented in Fig. 59, which admits of acting upon whole ones. About the middle of the upper part of the beam *B*, and near the socket, is a projection *D*, which supports the end of the lever that transmits its action to the hammer.

2. The anvil which receives the leather to be compressed, is composed of an iron cylinder *E*, having a brass face *a′*, like that of the hammer, and between these two the leather is pressed when the latter descends.

The cylinder passes freely through the socket of the large cross-piece *F*, and rests upon an elastic support, which allows it to descend a little under heavy pressure, and to rise again rapidly. This support consists of a thick wooden plank *G*, 20 inches square, fixed at its ends to the lateral projections *c*, which descend to the foot of the columns with which they are connected. This piece of wood-work is so large that it often has to be made of two pieces bound together by screws with nuts *d*. The cylinder does not rest directly upon this wood, but upon a steeled gudgeon, or pin, Fig. 60, *e f*. The gudgeon or pin is threaded for part of its length, and traverses a copper nut *g*, sunk in a cast-iron rim *h*, which is let into the centre of the wooden support. By turning this pin to the right or left, the cylinder and the anvil-face *a′* are made to rise or fall along with it. To effect this movement, the workman grasps a little fly *H*, the axle of which has an endless screw which works a toothed-wheel *I*, mounted upon the gudgeon. The fly is turned more or less, as the thicker or thinner parts of the leather are being exposed to pressure.

The leather placed between the anvil and hammer is thus pressed to any desired extent, and, the wood below being elastic, bends or gives to some extent, and again rebounds to its original position.

The cast cross-piece *F* which guides the anvil, rests at its two ends upon the projections *i i* of the columns *C C*, and upon each side of it is placed a table *J*, upon which the workman moves the hide in every direction, so that it may be touched at all points successively.

3. The lever which acts on the hammer. The head of the hammer *A* incloses a steel block, upon which a prop *j* pivots, which is of ovoid form and well-tempered steel (Fig. 57); and upon this prop the large lever *K*, moving upon the axis *k*, Fig. 61, is supported. When it descends, it rests upon the prop *j*, which oscillates a little upon its centre, and forces down the hammer in a vertical direction, and, in order that it may rise again with it, they are connected together by two iron bars, terminated by arms, which are attached on one side by the bolt *m*, which passes through the lever, and on the other by a similar bolt *n*, which goes through the head of the hammer (Fig. 57). The play given to these arms is regulated by small compressing screws above them.

The steel axis *k*, upon which the lever moves, rests upon the upper part of the projection *D*. A steel ring, traversed by the axis *k*, is adjusted upon the centre of the lever-head, and can be easily replaced when worn out. In order to retain this axle in place, it is covered on each side of the lever by two strong stays, the branches of which extend to the top of the beam, as well as to the projection *D*, and are kept in place by strong nuts.

M. Berendorf moves his machinery by a small oscillating cylinder engine, the power being transmitted to the lever *K* by the two beams *L L*, joined together by the double crank *M*. The vapor enters the conical box *Q*, from the boiler through the pipe *s*, raises the piston, and

escapes by the pipe *t*. The fly *R* turns the small crank *z*, and works the feeding-pump *S*, which is plunged in the reservoir *T*. The water is returned into the boiler by the tube a'', when the cock b' is open, and a ball-cock keeps up the communication between a reservoir above and the one below.

This machine works ordinarily at the rate of 140 revolutions in the minute, during which time more than a square yard of surface is compressed by it. In M. Berendorf's establishment, where a number of machines are constantly working, from 70 to 80 half skins are pressed by each apparatus in twelve hours.

Berenger and Co. have three mill-hammers at work, at the rate of 100 blows a minute, each one turning out from 35 to 40 whole skins in a day.

M. Berendorf has taken out a patent of fifteen years duration, dating the 7th of October, 1842, and, still later, two additional ones of improvements upon this interesting machine, which is now completely established in favor.

Cox's Machine.—A more modern method of rendering leather smooth and compact, is by passing it between rollers. This mechanical arrangement, being free from tremulous motions, and easily adjusted to any desired rapidity of action, produces a uniform and powerful compression throughout the side of leather, without any liability of damaging it, as is the case in machine *beating*.

Cox has invented a rolling-mill in which the roller is fixed at the end of a lever, which, being suspended, oscillates like the balance of a pendulum.

This roller, made of copper or brass, 5 inches in diameter and 9 inches in length, is suspended by its axes in the chaped end of an iron lever, 6 inches in diameter and 11 feet 10 inches long. The upper end of

this lever, also terminating in a chape, is movable upon pivots attached to a beam or block 15 feet long and 2 feet wide. This beam is free at its anterior extremity, and is so jointed at the other as to enable it to move upwards and downwards, and it rests on each side upon two supports placed below it. The weight is in a box resting upon the body of the lever, which is moved by the aid of a crank attached to it at a distance of rather less than two feet above the roller. The lever should move through a space of 3 feet 8 inches, but this can be increased or diminished. The copper or brass support is hollowed out, so that the roller can pass along its whole extent, and reach all parts of the leather. As soon as the hide is placed upon this support, the block or beam is made to rise, and the whole weight bears directly upon the leather. At the end of its course, where the support is flat, the roller is raised up by the beam, the weight is borne down again upon the leather when it reaches the middle, and is again elevated by the supports placed under the beam.

Fig. 62.

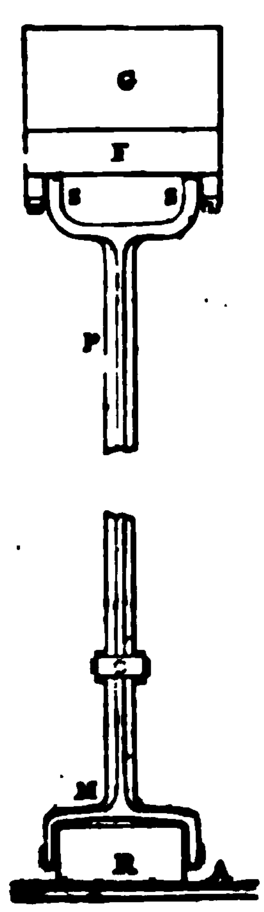


Fig. 63.

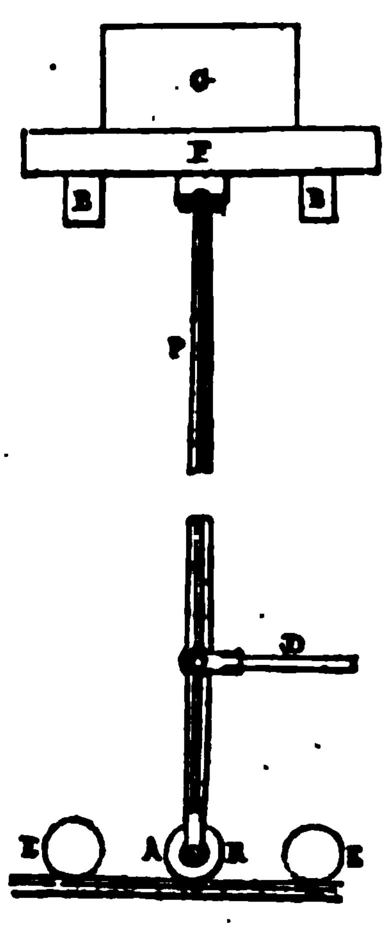
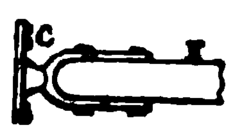


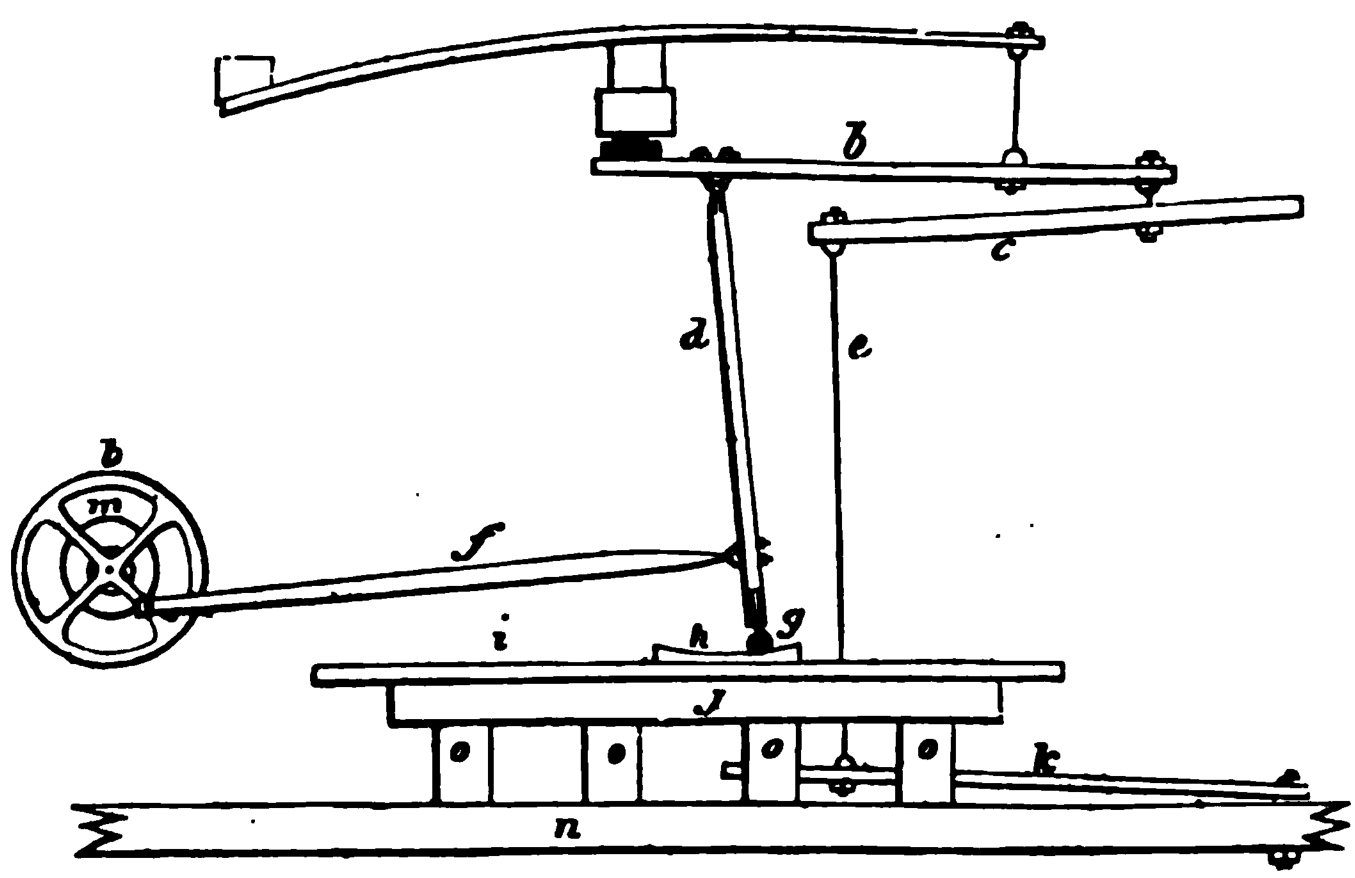
Fig. 62 is a front view, and Fig. 63 a side view, of this machine. *F*, beam, movable at its hind end by a hinge *C* fixed in the wall, (Fig. 64), and maintained in a horizontal position at the other end by the supports *B B*. *P*, lever joined to the beam *F* by the pivots *S S*, and terminated by a fork *M*, which holds the roller *R*, running over the curve *A*. This curve has, at either end, a plane surface *E*, where the roller leaves it and is raised up by the pivots *S*. *D* is the horizontal shaft connected with a crank which moves the lever *P*, and *G* is a box containing a weight heavy enough to cause the necessary pressure at the moment when the roller reaches the plane end of the support.

Fig. 64.



Wiltse's Rolling Table.—This machine, somewhat similar in construction to the preceding, is shown by the accompanying drawing, Fig. 65, made to a scale of the

Fig. 65.

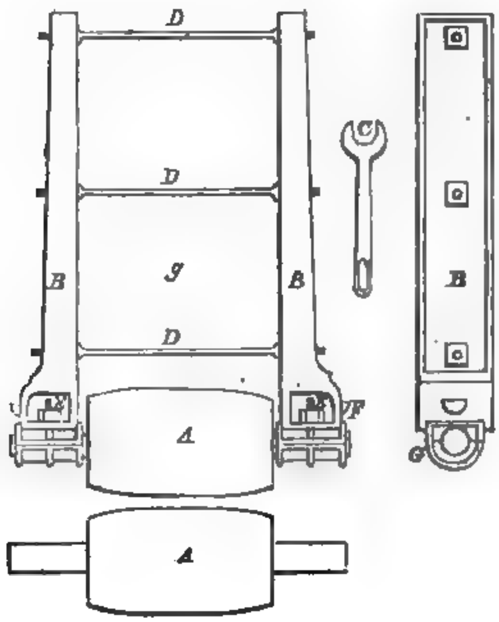


eighth of an inch to a foot. The machine consists of a spring pole, a lever *b*, to which the head of the vibrator *d* is attached, and which is rendered compound by a

connection with a second lever *c*. This combination acts through the vibrator *d* upon the roller *g*, and is propelled by the foot working the treadle *e e*. The bed *h* is of lignumvitæ wood, and the table *i*, upon which the leather is spread while being gradually drawn under the roller, is 8 feet wide and 16 long. The bed is the part upon which the leather is rolled, and is firmly supported by a heavy log *J*, which, in its turn, rests securely upon the supports *o o o o* and the sill *n* of the building. The connection *f* with the balance-wheel *b* forms a crank by which a vibrating motion is communicated to *d*. The pulley *m* on the same shaft is the driving medium, and the roller should move at the rate of 130 revolutions a minute.

Fig. 66 is a view of the rollers *A A*, one of which is

Fig. 66.



represented as it is retained in working position by the straps, *B B*, and the other detached. A side view of the strap is also given in a separate figure *B*. The wrench *C* is used for turning the nuts *E*. The lips *F F* are oil-holes for lubricating the journals of the roller.

The roller is made of a composition of copper and tin, with a steel shaft penetrating through it.

These mills and appliances are made in a creditable style of art by Wiltse and Co., Catskill, New York.

CHAPTER XV.

IMPROVED PROCESSES.

Having treated, in detail, of the practices of the art, as well as its chemical theory, the reader may now be considered sufficiently conversant with the subject to detect and apply the good points of the so-called "improved" processes which we are about to present.

Seguin, the friend and colleague of the lamented Lavoisier, devoted himself particularly to the improvement of the tanner's art, by chemical experiment and inquiry; and was the first to make known the distinction between gallic acid and tannin, and the property which the latter possesses of combining with various animal substances, especially gelatine, forming with it the unalterable basis of leather. The determination of this important fact revealed the key to the whole process, and was the foundation of his own researches and labors, as well as of those of all who have since followed in his footsteps.

SEGUIN'S PROCESS.

Seguin's mode of proceeding was as follows: His preliminary processes were the same as those of others, excepting, according to Dessables, that he directed the skins, after soaking and fleshing, to be rinsed in running water, so that all parts of them should be exposed to contact with it. He first deprived them of hair

by means of lime, and then deposited them in tan-juice, with which was mixed one-five hundredth, and sometimes one-thousandth part of sulphuric acid. For *raising* the hides, he first used a vat lined with a cement containing a little lime, and filled with water acidulated with one-fifteen hundredth part of sulphuric acid; but this did not answer the intended purpose, as the acid, instead of mixing with the water, combined with the lime. He therefore substituted wooden tubs for vats, filled them with water charged with one fifteen hundredth of concentrated sulphuric acid, which was gradually increased to one-thousandth part, and by this arrangement succeeded, according to the report made by him to the committee of public welfare, in *raising* hides in forty-eight hours. He asserted, however, that this operation of *raising* was not essential, and that he procured excellent leather from skins which had not been submitted to the treatment.

He did not stratify the skins in tan-vats, but placed them in vats filled with "ooze." For procuring this solution, a number of tubs were placed in a row, and filled with ground tan. A certain amount of water was then emptied into each tub, and filtering through the tan, dissolved out its soluble particles, and descending, ran into receiving vessels beneath. The liquid from the first vat was then thrown into the second one, and so on through the range, until it became saturated. As a considerable quantity of available material still remained in the tubs, they were affused with fresh water, which by a process of displacement, continued extracting the soluble matters until the tan was entirely exhausted.

Seguin placed the skins, after being taken from the acid bath, in a very weak infusion of tan, and there allowed them to remain only an hour or two for the pur-

pose of giving color to the hair sides. They were then taken out and immersed in a stronger solution, and again and again deposited in infusions, increasing each time in strength until the tanning was entirely completed.

Oak Tanning.—A patent was taken out in London, in the year 1804, for a tanning process, which is founded upon the principles established by Seguin. The oak bark is boiled for four hours in a copper boiler, and when the tan is perfectly exhausted, the decoction is allowed to flow off through tubes into the vats, where it is cooled. The skins are deposited in this after being soaked and pressed, and if they exhaust the liquor before the close of the process, a fresh decoction is substituted. If it is desired to have the hair side color whiter than ordinary, tan is mixed with the liquor. By this means a great amount of tannin is concentrated in a small quantity of material, and much less labor is required than in common; ten or twelve days producing as great an effect as eight or nine months of exposure by the old method. It is believed, however, that the skins are not thoroughly tanned by it, and that the leather is of deficient quality. The great quantity of tannin presented to the skins, tans their surfaces rapidly, and prevents the entrance of the liquid into the interior.

The patentees use, besides the ground oak-bark, the chips and sawdust of the wood, and ordinary furze, and recommend the employment of young shoots, the roots, and superfluous branches of the oak, by the use of which they say that they procure a stronger decoction than that from the bark of the trunk, which contains a thick matter incapable of being separated.

In 1819, new improvements were introduced. The trunk, roots, branches, and leaves of oak being asserted

to contain enough tannin to warrant their employment in tanning, were reduced to the state of chips or coarse powder, boiled in water, and used in the following manner:—

For the tanning of calf or other light skins, one hundred pounds of the middle parts or branches of the oak in chips, is boiled in a copper boiler, with fifty-two gallons of water until the latter is reduced to thirty-nine gallons. This liquid is decanted, and upon the residue, is poured a second quantity of thirty-nine gallons of water, which is boiled away to twenty-one gallons. This decoction is set aside and serves for the first bath of the calf-skins after they have been cleaned upon the horse, while the first liquor is used for the second bath.

To tan common skins, a hundred pounds of the middle parts or branches of oak in chips, seventy-five pounds of fresh coarse tan, and twenty-seven and a half pounds of the root, are boiled in sixty-six gallons of water, until the latter is reduced to two-thirds. The decoction is then decanted off from the partially exhausted matter, and fifty-two gallons more of water are poured upon it and boiled until reduced to one-half. This liquid is used as the first bath for the skins, and the one previously obtained as the second; and when they have been exposed long enough to both, enough fresh bark or tan-liquor to complete the tanning, is added. This method seems to be very incomplete throughout, and the inventors have failed to make known the proportions of tanning material to the number of skins, and the length of time required for the completion of the processes.

In these tannings, the skins were not thrown promiscuously into the vats, but were suspended vertically at intervals of about an inch from each other, so as to prevent the surfaces from touching; and to facilitate this

mode of suspension, they directed the heads of the skins to be cut off, and bands on each side having attached to them the legsand parts of the bellies, to be removed. The bodies of the skins were then to be divided into pieces proportioned to the depth of the vats, which pieces were to be suspended in them, while the other parts, being of less value, were thrown together into the bottom.

In tanning skins for uppers, after washing and fleshing them, Seguin directs that they be freed from hair by soaking in clear lime-water, and then, without being *raised*, tanned in weak solutions of bark made into a kind of ooze. The strength of these solutions was to be gradually increased, but not to the point of complete saturation, as in the case of strong hides. He succeeded in this way in tanning leather for uppers in three or four days.

The methods of tanning proposed by Seguin are rapid in the extreme, but they have not been generally adopted, since the leather made by them is inferior to that by the old process, and is less merchantable. It is possible, that if public business had not drawn away the attention of Seguin from his investigations, he might have succeeded in effecting a complete revolution in the art of tanning. As it is, he has had numerous followers, many of whom, in England and elsewhere, have patented and used variations of his process; but the essential objection to this mode of operating still attaches to all of them, namely, that the combination of tannin with the gelatine and fibrine upon the surface of the skins, takes place so rapidly, that the superficial layer of leather thus formed prevents the passage of the liquor into the interior of the hide, and consequently its perfect tanning.

Desmond has proposed a modification of Seguin's process, which consists in soaking the skins until the hair

gives, in a liquor saturated with tanning principle, and acidulated with a thousandth part, by measure, of oil of vitriol. When it is desired to *raise* the skins to any extent, they are immersed from ten to twelve hours in water containing a five hundredth volume of sulphuric acid, then rinsed in fresh water, and worked on the beam. Finally, they are soaked in a weak ooze, and after some hours, transferred to a stronger infusion, and left therein for several days. This last liquor must be replaced by fresh infusion as fast as it loses its tanning power.

GETLIFFE'S PROCESS.

This method, patented in 1812, consists in having a building with two stories, in the lower of which are the vats and boilers, and in the upper, the leech-tubs for preparing the tan-liquor. The loft may be arranged as a drying apartment.

Boiling water is raised by means of a pump, from a boiler below into the reservoir, and a pipe connecting the two returns the extract of tan to the boiler, from which it is distributed by means of pipes with stop-cocks, into the different vats. These vats are supported upon framework, and passing around them are pipes, by means of which their contents are kept at a uniformly elevated temperature. Each vat also has a stop-cock in its lower part, which permits its contents to be emptied, when it is desired.

The rough skins are thrown into the vats; and are said to be tanned in them in one quarter of the usual time.

NOSSITER'S PROCESS.

This new method was patented in England in 1844, and consists in depositing the skins in pits so that they

shall not be subjected to the pressure of those placed above them, and in pressing out the exhausted infusion contained in them, before immersing them again in fresh ooze.

1. The skins being superposed, in the old method of tanning in vats, those which are below are so compressed that the tan-liquor penetrates their structure with difficulty. To avoid this objection, the inventor proposes to deposit the skins in square vats, and to separate them by the interposition of rectangular frames with ledges. By this means the skins are perfectly free from contact with each other while in the tan-liquor.

Fig. 67 represents a horizontal section of the vat, and a frame with a skin stretched over it.

Fig. 67.

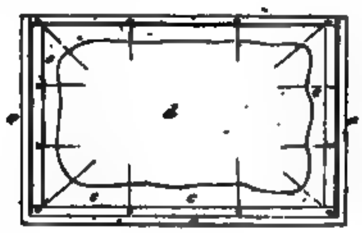


Fig. 68 is a vertical section, showing the frames in stack, and the skins between them.

Fig. 68.

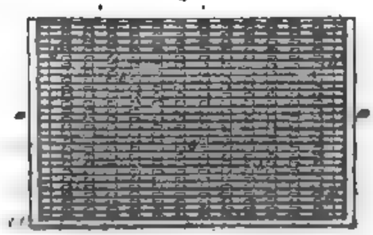


Fig. 69 shows the plan of the bottom of the vat.

Fig. 69.

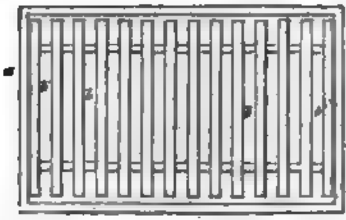


Fig. 70, plan of the frame.

Fig. 70.

a, a. Vat, of the ordinary form; *b, b,* wooden frame, with crosspieces; *b′* ledges, for maintaining the pieces in position.

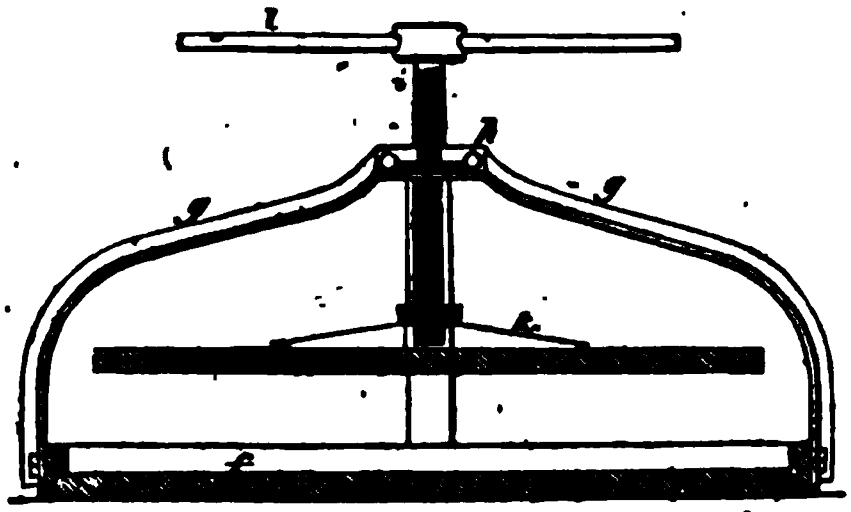
This method of tanning is much more expeditious than the old way; for although fewer skins can be tanned by it at one time, it admits the working of a greater number in a given time, and in the same vat.

The vat is first filled with the skins and frames, and the tan-liquor is then introduced. When this latter is exhausted or weakened, it is pumped out and replaced by fresh ooze.

The skins are deprived of exhausted liquor, in many establishments, by pressure between rollers; but as this method does not fully effect the object, Nossiter subjects them to the action of a screw-press, which is seen in vertical section in Fig. 71, and in the plan, Fig. 72.

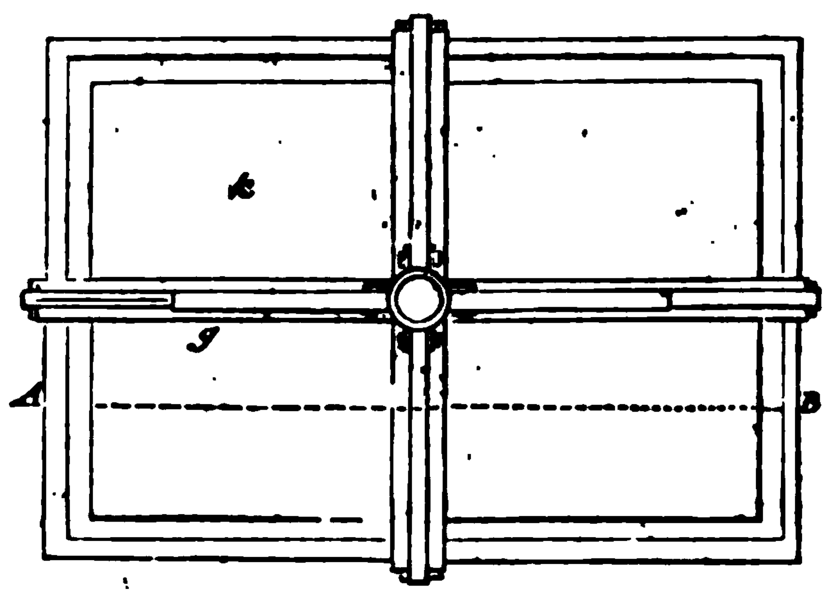
This press consists of a strong rectangular support *f*, from the four corners of which arches spring, which

Fig. 71.



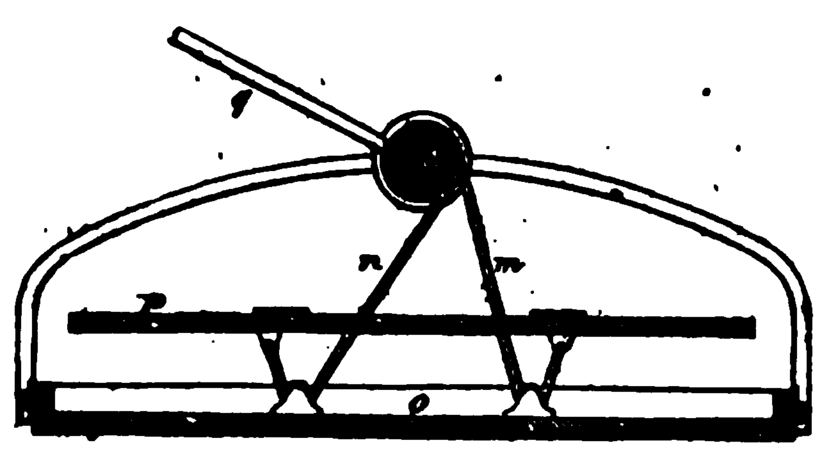
meet in the centre in a square nut *h*, in which the strong screw *i* turns. The skins are placed above each other

Fig. 72.



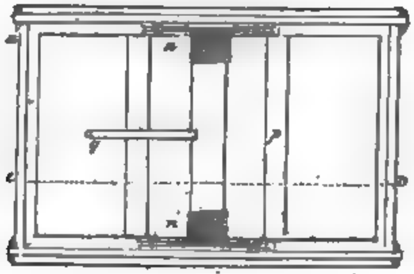
on the table of the frame, and are pressed by the plate *k*, at the lower end of the screw, which is turned by the lever *l*. The skins are subjected to this pressure until all their fluid contents are expelled.

Fig. 73.



In place of the screw-press, one with an axle, seen in Fig. 73 in vertical section, and in Fig. 74 in plan, may

Fig. 74.



be used. Around the axle *m*, the cords *n*, *n*, are rolled, which pass through pulleys in the supports. The cords are passed at their ends through screw-rings on the sides of the under surface of the plate *p*. By turning the axle with the lever *q*, the upper plate is made to compress the skins which are placed below it.

OGEREAU'S PROCESS.

Ogereau, one of the most eminent tanners in Paris, proposes to lessen the duration and labor of the tanning process, by a methodical arrangement of materials. He places alternate layers of tan, and of the skins which have been properly prepared by the ordinary method of separating the hair and of *raising*, in a vat with a perforated false bottom. This vat being three-quarters filled, is then drenched with water for the first operation, and with weak tan-liquor which has been already used, for the succeeding ones. The liquid penetrates the mass slowly, and having moistened all the contents, passes through the false bottom into a reservoir, from which it

is carried up and again thrown upon the surface of the materials in the vat by means of a pump.

The arrangement of Ogereau consists, according to Dumas, of six vats, each of which is capable of containing 100 domestic or 120 imported hides. The liquid which percolates through the contents into the reservoir below, is daily distributed over the surface by pumping, a constant circulation of fluid being kept up, which is thus alternately receiving tannin from the bark, and rendering it to the skins. This operation is continued for a month; at the end of which time the vat is emptied, the spent tan replaced by fresh, and the same process is recommenced. A third exposure to fresh tan and repeated filtrations are necessary before the skins are properly prepared.

All the parts of this process, including the preliminary preparation of the skins, occupy less than four months, and the leather obtained by it is equal in quality to any procured by the old methods. A hundred parts of dry Buenos Ayres hides gives one hundred and fifty parts of leather.

CHAPTER XVI.

VAUQUELIN'S PROCESS.

THIS process consists in the use of a machine by means of which hides are deprived of hair, and rendered soft and supple without the aid of chemical agents, and by which they are also fleshed, and reduced to a uniform thickness, thus saving much time and labor; and finally of a particular means of tallowing and dressing them.

The hides are soaked while still raw for a sufficient length of time, usually about forty-eight hours, and are then subjected to the action of the fulling machine, represented in Fig. 75, for an hour. They are thus made pliable and ready for being worked.

They are then placed in another apparatus, exhibited in Fig. 76 (a kind of churning-vat), to the joint action of which, and of the steam that is let in to keep up a temperature of from 104° to 113° (Fahrenheit), they are exposed for some time. After the completion of this part of the process, they are placed in a suitable vessel and are kept for twenty-four hours under a current of tepid water.

Great care must be observed in preserving a uniform temperature throughout, and to this end it is necessary to test the heat occasionally with a thermometer or the hand.

No other process is required for dehairing when a small number of hides are operated upon; but as economy of time is an important consideration when working upon a large scale, Vauquelin uses weak lime-water, the temperature of the bath being proportioned to the number of hides. The hair will then come of with great ease, and the skins are carefully and thoroughly *fleshed* by means of a machine represented by Figs. 77 and 78.

The hides, after being fleshed, are worked in the fulling machine for a length of time, varying according to their nature, and are then replaced in the vat (Fig. 76), and impregnated during some hours with a weak tan-liquor. They are then taken out, piled up for two hours, and again deposited in an infusion stronger than the first one, and during the first three days are handled three times daily, and after that time, once a day. Every forty-eight hours they are filled and treated for half an hour in the churning-vat, with the same liquor in which they are left throughout, until thoroughly saturated. The alternate action of the filling stocks and churn-vat softens and opens the texture of the hides, and renders them more pliable and capable of absorbing the tan-liquor, thus promoting economy of time and money.

Another mode of preparing the skins is to place them in the vat (Fig. 76), and to introduce steam into it, so as to elevate the temperature of the liquid to from 104° to 113° F. The skins are kept in a state of constant agitation and movement from the bottom to the circumference of the vessel by the arms c, and this churning is continued until they are deprived of the greater portion of their hair. They are then deposited in another apparatus (Figs. 79, 80, and 81), which is moved by suitable means. It consists of a barrel or cylinder, lined with pegs, and revolving in a reservoir of water, the level of which

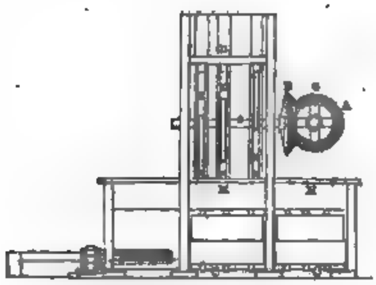
is about half as high as that of the pegs. The skins are, by this rotatory motion and friction, deprived of their hair, which falls to the bottom and flows off with the water through a metallic grating. After this process, the skins may be shaved and fleshed as before described.

The method of tallowing the leather, as prescribed by Vauquelin, is as follows:—

After the skins have been properly tanned, their whole surface is daubed over with a mixture of oil and tallow, and they are placed in a peg-lined cylinder, or drum. This drum being made to revolve rapidly, the pegs impinge upon the surfaces of the leather, and at the end of half an hour, the grease will be found to have penetrated it so perfectly and uniformly that the surface will appear quite dry. It is then taken out, stretched, and dried.

Description of the Figures.—Fig. 75. This represents

Fig. 75.

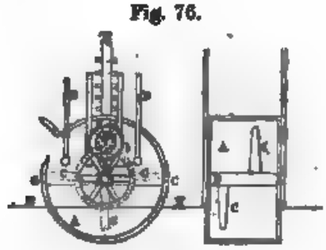


the beating or fulling machine. A, B. Cog-wheels, giving motion to the shaft O, and to cams upon it, which alternately raise and lower the hammers E, E, E, to which the bar D serves as a guide. A movable trough for the skins is seen below. C, C. Cocks, which allow the liquid matters contained in this trough to escape. H, H. Openings, through which the skins are introduced into the trough. I. Rack and pinion, by means of which the trough is

moved to and fro, so as to bring all parts of the skins successively under the hammers.

Fig. 76. Churning vat. This may consist of an open

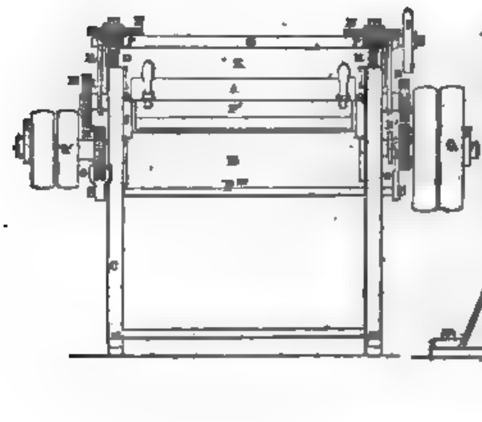
Fig. 76.

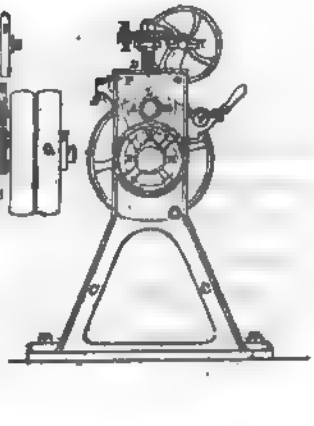


vessel, but a closed one will enable the operator to maintain a more uniform temperature. A. Vat, closed by its lid. B. Shaft, carrying the cams or arms C, C. D, D. Tubes, through which cold and hot water, the tanning liquor, and steam are introduced. E. Ladder, by which the workman descends and regulates the cocks. F, F. Ground level. G, G. Water level in the vat. H. Door, which closes the opening in the vat. *a*. Toothed wheel, communicating its movement to the wheel *b*, and the shaft. The arms of the shaft are straight, but may be made of various shapes.

Figs. 77 and 78. These figures represent the machine

Fig. 77. Fig. 78.





for fleshing and paring the hides after they have been properly soaked and softened.

It is composed of two cylinders, A and B, of copper, or other suitable metal, mounted upon a framework C, C, and forming a kind of cylindrical press. The upper one can be elevated or depressed by means of screws D, D, in the upper crosspiece of the frame, which act both upon the fixed supports H, H, and upon the sides of the frame. Upon this crosspiece, a shaft with a small fly-wheel I, works the endless screws F, F, which turn the cog-wheels E, E, by means of which the screws D, D, are turned in either direction. These screws carry, just below the wheel F, two shoulders or collars upon which the bar K is supported, and at the extremities of this bar, two descending cushions L are attached, which support the shaft of the cylinder A, and which are elevated or lowered by the bar, in accordance with the movement of the screw D. At the two extremities of the cylinders are cog-wheels of different diameters, M, N, M', N'. Those on the shaft of the lower cylinder B, are so attached to it, that it shares in their movement, while they are movable upon it, and can be slid to the right or left by two forks Q, Q, fastened to the bar P''', which passes across the framework. The wheels M, M', are geared with each other when the cylinders are a certain distance apart, and those at N, N', engage in turn, when the cylinders are brought in contact with each other, so that the cylinders turn simultaneously in either of these positions. At the extremities of the cylinders, there is a system of pulleys which communicate the motion to the machine by means of straps.

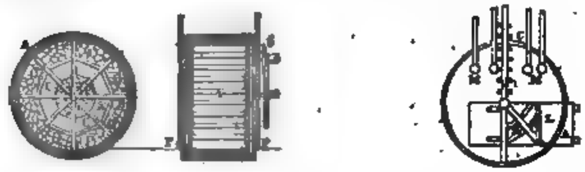
Upon the interior and posterior faces of the machine, two knives P, P', are fixed, which turn upon cushions supported by the pieces *q*, *q'*, seen on the frame. The

knife P, has a cutting-blade, which is retained in place and adjusted by means of screws, but the knife P′ is dull.

The skin, placed upon the upper cylinder, is drawn in, compressed, and stretched out in the direction of its length, between the two rollers. The wheels M, M′, are then put in gear, and the knife P′ is made to pass over the skin by pressing it against the upper roller by means of a movable piece with two handles. The skin being now pressed between the rollers and gradually advancing through them, the cutting blade which is parallel to the surface of the cylinder is put in action, and, like the ordinary fleshing-knife, it removes all the projections from the flesh side, and equalizes the thickness of the skin.

Figs. 79, 80, and 81. These figures represent the re-

Fig. 79. Fig. 80. Fig. 81.



volving cylinder or drum for depriving the skins of hair, which has already been partly described.

A. Exterior of the drum; B, B, shaft of cylinder; C, cylinder; D, crossbars, forming the framework; E, F, separate pieces of the set of crossbars; G, G, internal surface of the cylinder; H, wooden projections, fixed upon this surface; I, metallic plate, closing the surface of the cylinder; L, door, closing the aperture; M, M, tubes, through which water, tanning liquor, and steam are introduced into the cylinder; O, ladder, for the workman who attends to the stopcocks, to descend; P, level of liquid in the cylinder; *b*, *b*, cog-wheels, communicating motion to the cylinder.

Figs. 82, 83, and 84. These figures exhibit different

Fig. 82.

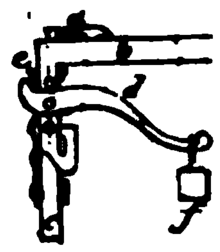


Fig. 83.

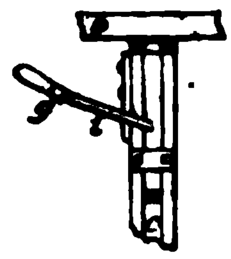


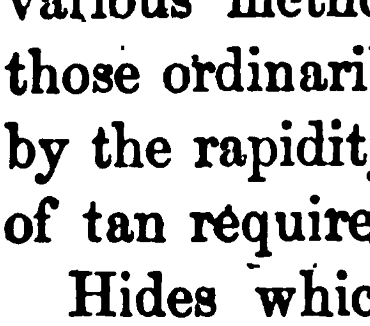
Fig. 84.

means of keeping the skins pressed upon the table when they are subjected to processes of paring by hand.

a, *a*. Clamp or press for maintaining the skin in place; *b*, *b*, the table; *c*, *c*, a vertical bar sliding in a groove; *d*, the lever which acts upon the press; *l*, a catch which stops the lever *d*; *f*, weight at the end of the lever; *g*, another lever by means of which the press is raised, as has been before explained.

Fig. 85 represents the press commonly used in this mode of preparing leather.

Fig. 85.



The committee on chemical arts of the *Société d'Encouragement*, reported, in the bulletin of the Society, most favorably upon the processes of Vauquelin. They believe that the expense of the various methods used by him does not exceed that of those ordinarily employed, while a great gain is secured by the rapidity of the process, and the smaller quantity of tan required by it.

Hides which are difficult to treat in the ordinary mode, are tanned and prepared by this one as easily as any others. They gain instead of losing weight in the various currying operations, and in the opinion of the committee, and of numerous manufacturers and dealers in the article, they exhibit all the evidences of being equal or superior to the very best leather.

The same committee again reported to the Society, in 1844, in the following manner:—

"At the meeting of your Society, on the 11th day of August, 1841, a gold medal was voted to M. Vauquelin, for his new tanning processes. Since that time he has succeeded in overcoming difficulties which seemed to be insuperable, and in order to convince you of the rapidity and excellence of his methods, we present you with the results of the experience we have had of them.

"Your committee, on the 9th of January, 1844, marked, at the establishment of Vauquelin, one hundred calf-skins, the total weight of which amounted to 398 pounds; three cow-hides, weighing together 15 pounds, 7 oz.; and upon the 15th of January, 1844, two horse-hides. These skins were found by them to be perfectly tanned, the calf-skins upon the 18th of March, the cow-skins upon the 4th of April, and the horse-hides upon the 12th of April of the same year. One of the calf-skins having been reserved by them for special purposes, the ninety-nine remaining ones were found to weigh 375 pounds, and the cow-skins to weigh 19 lbs. 13 oz. The weights of the skins, when tanned and curried, compared with those found before the tanning, indicated that the former had suffered a slight loss, and that the latter had gained about 27 per cent.

"Thus the calf-skins were tanned perfectly in sixty-eight days, the cow-skins in eighty days, and the horse-hides in eighty-seven days; while, if they had been exposed to the ordinary processes, from twelve to fifteen months, or even more would have been required. These results show the astonishing rapidity of the process; and the skins themselves can be seen at the Exposition of Products of Industry, where all can convince themselves of their thorough tanning and excellent quality."

An officer of the French army, Col. Chomprè, gives the following notes of his experience in the use of Vauquelin's leather:—

"1. A piece of calf-skin, forming a patch on a pair of trowsers, which were ridden in by a dragoon every day for eight months, was found at the end of that time in a perfect state, and as pliable as at first.

"Another piece treated in the same way for four months, and exposed to constant friction, was equally uninjured.

"2. A number of pairs of calf-skin boot-legs wore exceedingly well, preserving their firmness and pliability without any unusual care being used for their preservation.

"A pair of boots with ordinary tops, and with soles made of the tail part of the horse-hides, was worn by a non-commissioned officer, who generally wears out a number of shoes. These are now in a perfect state, and, according to his account, have lasted as long as two pair of ordinary soles.

"Five other pairs of soles of shoes given to lancers, who wear out a great many in service, are in an excellent state of preservation.

"3. The blackened leather, used for belts, girths, and stirrup straps, has also worn well.

"The conclusions of the report of the administrative council of the regiment are, that the leather submitted to and tried by them, was superior to any which had before come under their notice."

CHAPTER XVII.

ACCELERATING PROCESSES.

Numerous processes have been devised for shortening the time of tanning. Their relative merits must be determined by the experience of the tanner; and we therefore present detailed descriptions of those which are seemingly worthy of notice. As a general rule, the gain in time is at the expense of the quality of the leather.

BERENGER AND STERLINGUE'S PROCESS.

This process, patented in 1842, obviates the inconveniences attending the old methods of tanning, particularly in the separation of hair from the skins. Its object is to reduce the time occupied in tanning, often amounting to sixteen months, within the reasonable limits of from four to five months, thus avoiding the extreme of allowing too short a duration for a process which, to be successful, must be more or less gradual and prolonged.

When skins are deposited in the vats, with water and layers of tan in the ordinary quantities, the infusion formed is usually found to indicate 25 degrees of the hydrometer. In proportion as the combination between the gelatine and tannin progresses, the strength of the liquid diminishes, until after four months of contact, the hydrometer stands at about 8 degrees. At the end of this time, the skins are deposited in fresh vats, and this

change is repeated a third and often a fourth time, at every interval of four months, the hydrometer sinking successively each time, from 25 degrees to about 10, 12, and 15. Thus, the introduction of tannin into the substance of the skins, becomes gradually more and more difficult and slow, owing to the increased obstacles to the penetration into the tanned surfaces. The knowledge of these facts induced the inventors to devise means of tanning which should, unlike those ordinarily used, keep the skins in contact with infusions gradually and constantly increasing instead of diminishing in strength. For this purpose they placed a wooden cylinder in the vats, through which the infusion could be removed by pumps and replaced by fresh and stronger liquid when necessary. They succeeded, by these means, in tanning in a comparatively short time, and in avoiding the renewal of the contents of the vats; but the proceeding was not yet sufficiently perfected to give it the necessary precision and certainty.

Eighty tubs-full of water are required to moisten a freshly filled pit, the tan absorbing much the largest portion of it, but only about ten tubs of infusion can be pumped out unless the pit is pressed and drained, which injures the hides and alters their relative position, so as to diminish the value of the leather. In fact, the simple withdrawal of the amount of fluid above stated, leaves the surface of the pit sunken and disordered.

To avoid this difficulty, Berenger and Sterlingue attempted successfully, and with good results, to remove the old infusion from the pits, at the same time that it was exactly replaced by the introduction of fresh and stronger liquid; but the mode adopted by them was deficient in regularity and certainty, and it became necessary to devise better means for the attainment of

their object. For this purpose, they provided a row of vats with wooden cylinders, which were connected above at a depth of six inches below the surface of the pits, by means of a pipe passing from one to another, and which communicated below, by means of a perforated tube, with the open space of a false bottom in the pit. By means of this arrangement, it was only necessary to open a cock of fresh water into the weakest pit, to enable the fluid, which had no other means of escape when this was filled, to traverse the whole range of pits, filling each one, from the weakest to the strongest, in succession, before it was possible for any of it to enter the next one.

We will now suppose a series of eight pits to be thus arranged, each one provided with its cylinder, opening by a perforated tube into the false bottom, and connecting with the cylinder of the next pit at a depth of six inches below the surface. Hides are then stratified with tan in the end pit, and water is poured into it in the ordinary manner. After from fifteen to twenty-one days, a second pit next to the first is filled with the dry tan and skins, and since 80 tubs-full of water were required for the saturation of the first one, the same quantity of a stronger infusion, properly graduated, is poured into the first pit, and this liquid descending, drives before it and takes the place of that originally contained in it, which has then no other means of escape than to pass out into the second pit through the communicating pipe, in quantities exactly proportioned to those which enter the first one. Fifteen or twenty days after this operation, it is repeated in the same way, a stronger infusion being introduced into the first pit for the purpose of filling the third one with the liquid contents of the second, and the second with those of the first. The same proceeding is repeated at the same intervals until the eighth and last pit is filled.

The communicating pipe is then closed, the infusion is pumped from the first pit, and the leather taken out to dry, a fresh supply of hides and of tan being deposited in this, which has now become the eighth pit of the series. The one which was before second, being now first, is to be supplied with 80 tubs-full of strong infusion.

Thus, by this process, one application of tan is alone required, the pits are not changed until the leather is finally removed from them, and a great economy of time and labor is secured. Its duration is generally from four to six months.

Four months' exposure in eight pits is sufficient, if the strong infusion is added every fifteen days, but if the operation seems to be progressing too rapidly, the interval may be lengthened to three weeks or a month, in which case, from six to eight months will be occupied. The number of pits may be increased or diminished at will. One hundred and twenty pits could even, were it desirable, be placed in connection with each other, which would require, after the perfection of the leather in one of them, that one pit should be daily emptied of its contents, and refilled with fresh skins and tan, 80 tubs-full of strong infusion being at the same time poured into the oldest one.

The infusion for watering the pits is prepared, or rather renovated, in the following manner:—

As the leather is taken out to dry, the infusion from the same pit is transferred to a set of vats which are especially provided for the purpose, and which are like those used to furnish the liquor for tan baths.

These infusions are lixiviated as above described, and a sufficient quantity of fresh tan is mixed with them to give the requisite strength. Thus, if the liquid be only at 30 degrees of strength, and is required to reach

60 degrees, it is placed in a large, raised reservoir, which connects with a trough. This trough communicates by means of a tube with a second, a third, and a fourth trough below each other, all of which have pipes running longitudinally along their bottoms. Steam is now passed along these tubes so as to heat the infusion which passes successively through the troughs, and to concentrate it to any desired point, so as to increase its strength and deprive it of the fatty matter and gallic acid which it may have acquired in its passage through the pits. It is finally let off by a stopcock into a reservoir below, where it cools, and is in a fit condition to be poured into the pits.

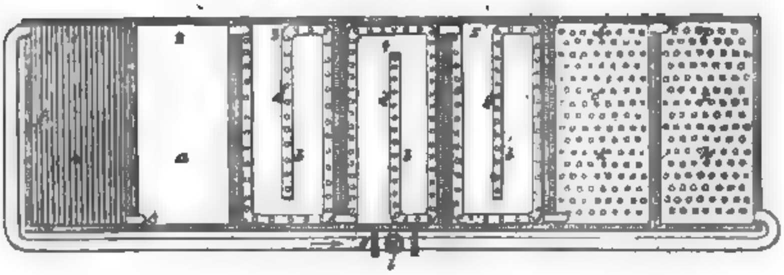
The same system of continuous tanning is applied by the authors to baths of tan-liquor. The skins are not, however, daily transferred from the vat containing the weaker liquor to that of the stronger, as in the ordinary method, but are placed upon horizontal shelves adapted to each vat, and are not taken out until ready for the tanyard; the liquor itself being passed from vat to vat, as in the pits. In the same way it may be made to replace the old system of tanning the skins by floating them in tan and water. In that process, the skins, infusion, and tan, are all thrown together into the vats, and, after a time, the skins are taken out, the infusion is drained off from the tan, and replaced in the same vats with the skins and fresh bark, the operation of change being frequently repeated until complete tanning is effected. By the present mode, these repeated removals are not necessary, it being sufficient to introduce fresh liquor into the oldest vat of the series, and to keep it constantly full, so that the others will be filled in succession. The tanning will be more complete, regular,

rapid, and economical; all the labor necessary in the other process being saved.

Fig. 86.

Figs. 86 and 87. Apparatus, for giving the baths to hides; 1, 2, 3, 4, 5, 6, 7, square vats, forming a series.

Fig. 87.



a. Skins *h*, placed from head to tail, across horizontal crosspieces *f*, and resting upon them without touching each other.

b. Exhibits the bottom of the pit, with the false bottom taken out; and *c* shows the latter in place.

d. Tubes in the bottoms of the pits, pierced with holes to receive the infusion. Their vertical parts, *e*, are not pierced, but conduct the fluid upwards from the bottom of one vat to the top of the next one. Their upper extremities turn horizontally into the adjoining pits, so that that they cannot communicate excepting through these tubes.

g. Horizontal tube, connecting vat No. 7, with No.

As all the vats communicate, fluid poured into one, readily passes through all.

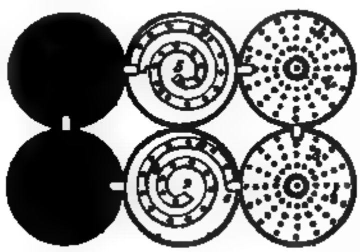
i. Cock, to prevent connection between Nos. 1 and 7, when it is not desired.

k. False bottom.

l. Arrows, indicating the direction of the motion of infusion from 7 to 6, etc.

Figs. 88 and 89. Series of pits. 1, 2, 3, 4, 5, 6, pits, forming a series.

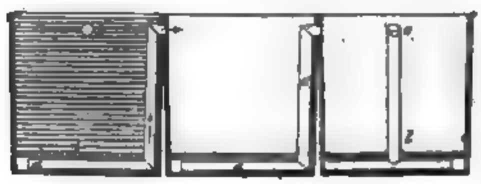
Fig. 88.



a. Skins deposited in pit, alternating with beds of tan.

b. View, or plan of pits, with the false bottoms re-

Fig. 89.



moved, and showing *d*, tubes curved and pierced with holes in this part alone; the vertical portion of the tube passing up and turning over under the surface, into the next pit.

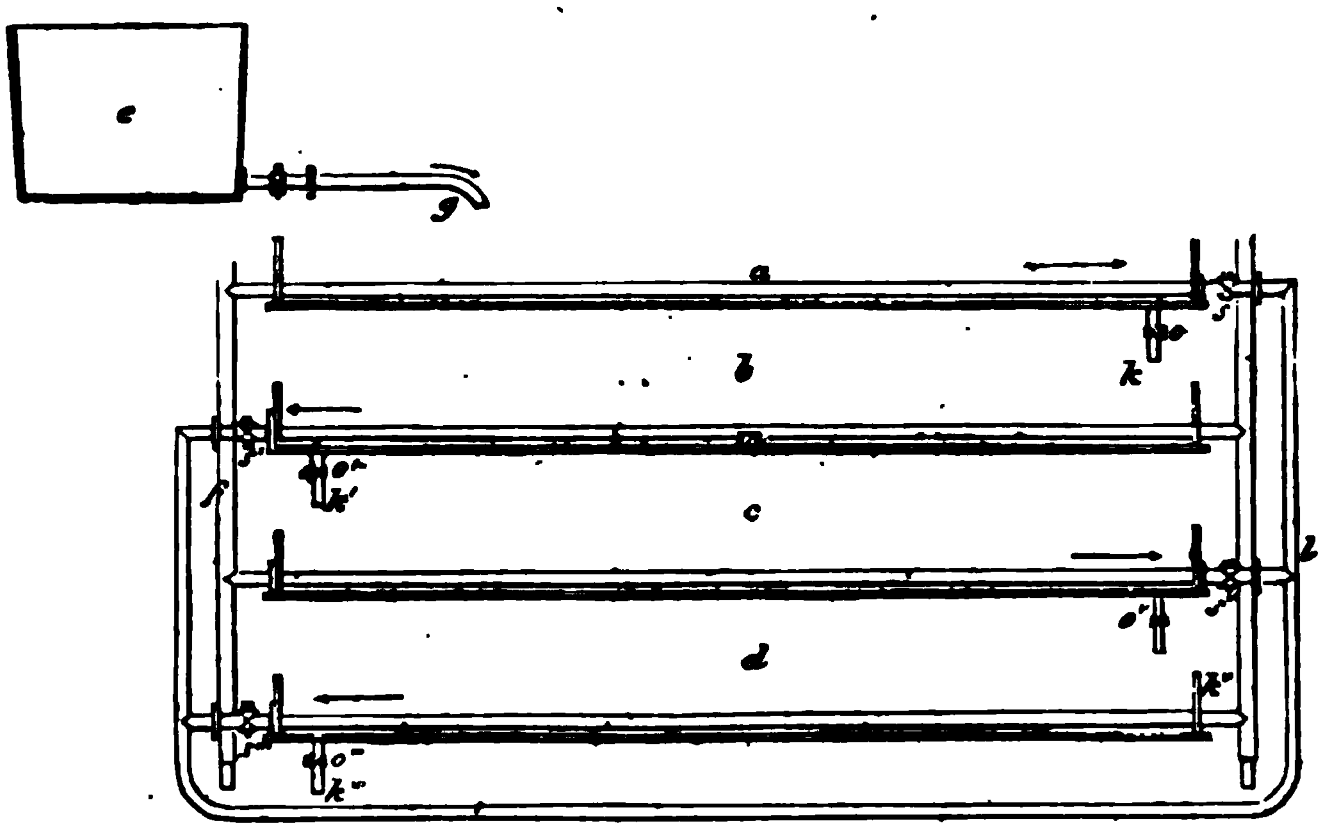
a. Plan of pits with the false bottoms in place, above the tubes.

i. Arrow, showing the movement of fluid from one pit to another.

k. Bungs, or stoppers, used when necessary, to prevent the passage of fluid.

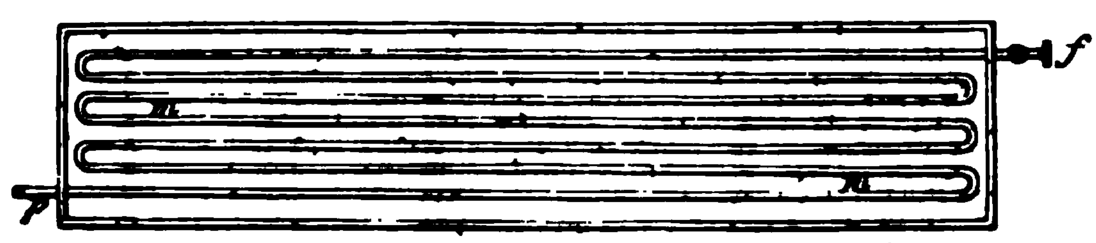
l. False bottoms, cullendered.

Fig. 90.



Figs. 90 and 91. Apparatus for regenerating old tan-liquor, and concentrating it to the desired strength.

Fig. 91.



a, *b*, *c*, *d*. Troughs, placed one above the other, so that the infusion in *a* runs down into *b*, into *c*, and into *d*, through the tubes *k*, *k'*, *k''*, *k'''*, with the stopcocks, *o*, *o'*, *o''*, *o'* .

At the bottom of each trough is a serpentine tube *m*, extending over the whole surface, as seen in the plan. The vapor enters each tube upon opening the stopcocks *s*, *s'*, *s''*, *s'''*, in the tube *l*.

e. Reservoir, in which the liquor to be purified is first placed. It escapes from this through the tube *g*, into the first trough. When this is full, the fluid still running from the reservoir, the cock *o* is opened, and the warm and already partly concentrated fluid runs into reservoir *b*, and so on successively, until the concentrated liquor passes through the cock o'''' into a trough in which it is allowed to cool.

f. Escape-pipe, conducting the condensed water and waste vapor into the open air.

p. Pipe, for the entrance of steam.

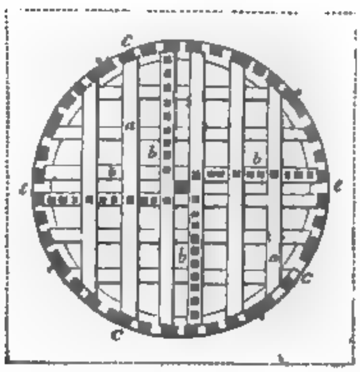
The drawings represent only six and seven elements of the series of pits and vats, while reference has been had in the text to eight.

SQUIRE'S PROCESS.

This process, patented in 1844, consists in depositing the skins in a horizontal wooden cylinder, which is made to revolve slowly, under the surface of hot tan-liquor, so as to insure constant agitation of the hides and skins, and perfect exclusion of air.

Fig. 92 represents a transverse vertical section of the

Fig. 92.



apparatus, as placed in the vat: *a*, wooden drum, 12 feet long and 7 feet in diameter, lined with ridges, and divided into four compartments by the partitions *b*, *b*, which are composed of wooden staves, or bars with open spaces between them. Hot ooze, and some of the tanning material are then introduced with the prepared hides through a water-tight door *c*. The vat should be deep enough to admit the submersion of the whole cylinder, which is to be kept in uninterrupted motion, at the rate of six or seven revolutions per minute; and for this purpose its axle *d*, resting upon upright supports, is turned.

This is really an accelerating process, for the use of hot ooze, and the continuous contact of the skins with the tan-liquor, shorten the time for complete tanning to two weeks. Moreover, it permits the use of divi-divi, catechu, and other readily oxidizable tanning materials, which, when used in open vats, color the leather and render it unsalable. The access of air in this process being limited, this disadvantage is avoided.

The ooze spends its force very rapidly, and must be replaced by fresh hot liquor as fast as it becomes exhausted.

TANNING BY MECHANICAL PRESSURE.

This ingenious method, proposed by Spilsbury, although attended by good results, has not been as successful as was originally anticipated.

The inventor proposes to avoid, by his new arrangements, the deficiencies of the ordinary processes, in which skins, impregnated with water, are exposed, under very unfavorable circumstances, to weak tan infusions.

The hides, after being carefully depilated, and prepared, and having all the holes sewed up, so as to render

them water-tight, are tightly stretched, by means of clamps, upon rectangular wooden frames.

The frame, on which the hide is stretched, is exactly overlaid by another similar frame, which is to be screwed down so as to confine the edges, and make them water-tight. Another hide is stretched, as before, over the upper ledges of this second frame, and a third frame screwed down upon it, as in the first instance, and the whole three securely bolted together by means of clamps, so as to form, as it were, a water-tight vat. The frames are then set upright, and the ooze allowed to flow into the space intervening between the two skins, through a pipe leading into it from a reservoir above. A hydrostatic pressure is thus maintained, and the liquid column forces the ooze through the structure of the hides by slow infiltration, and thus brings all parts in direct contact with tannin.

There must be a stopcock in the bottom of the vat to allow the escape of confined air as the ooze enters, and the exit of the spent liquor at the completion of the tanning; but care must be taken to close it when the vats are full of liquid, and in operation. There must also be a stopcock in the pipe leading from the reservoir to the vat, so as to shut off the communication when the process is finished.

The exhausted liquor is let off through the stopcock, and replaced by fresh, and as soon as the skins are completely tanned, the frames are taken apart, the edges of the hides pared off, and the leather dressed in the usual manner. The process is rapid, but its duration varies in accordance with the amount of pressure, the strength of infusion used, and the kind and quality of the skins. The necessity of clipping and sewing the skins causes more or less loss of material.

The above process has been improved by two modifications, one of Wm. Drake, and the other of Mr. Chaplin: Drake's process consists in giving the hides, prepared as usual, an incipient tanning by immersion in a weak ooze. After the necessary handling, they are taken out and sewed together at the edges, grain side within, in pairs so as to form water-tight bags, with small holes at the ends, for the admission of the tan-liquor. The bags are then suspended, by means of loops, between two upright wooden racks, to prevent bulging when full. The cold ooze is then introduced through a funnel, and by keeping the bag distended, creates a pressure, which causes the liquid to infiltrate through the skin.

The fluid, passing through is received in a vessel beneath, and returned, as it accumulates, to the sack. Towards the close of the operation, when the skins become firm and hard, the temperature of the room, previously well ventilated, is raised from 68° to 149° F., and this temperature is maintained until they begin to darken in places, and the liquid ceases to lose strength, when they are taken down, are emptied of their contents, and prepared in the usual manner.

The elevation of temperature, by causing the evaporation of the liquid on the external surfaces of the skins, promotes the infiltration of the ooze. To prevent indentations, by prolonged contact with the wooden bars, the position of the bags should be occasionally shifted. By this process it is said that a skin can be as well tanned in ten days, as it can be by the old one in ten months; but as to the quality and durability of the leather, we cannot speak definitely, except as to its appearance, which is very favorable.

Mr. Chaplin proposes to lay the bags in an inclined

position, and to turn them frequently, so as to equalize the tanning of the hides.

Another modern improvement, consists in combining the infiltration process with the old Danish method: that is, the bags filled with ooze, are, during the action of the hydrostatic pressure, to ke kept immersed in the tan-vat.

The chief objection to the infiltration process, is the unequal permeability of the hides, as some portions imbibe the ooze liquor more readily than others. The prolonged distension of the hides is also liable to weaken their structure, and consequently depreciate the quality of the leather. The precaution of modifying the internal pressure, by suspending the bags between wooden supports, only partially remedies the defect; for the portions protruding between the spaces are still liable to injury from unequal pressure. The laying of the bags in an inclined position, and turning them frequently, is an improvement upon the old process, but does not insure uniformity.

John Cox, of London (*Rep. Pat. Invent.* 1845), proposes to equalize the distension by suspending the bags in a coarse canvas casing, instead of wooden racks. The porous texture of this material will allow the easy passage of the infiltrating liquor, while, at the same time, by its ready adaptation to the surface of the bags, it sustains them firmly, and with a uniform pressure.

The advantage of Spilsbury's process, arising from the unequal permeability of the hides, is said to be obviated, by an improvement made by J. F. Knowlis, which is as follows:—

The hides are suspended in an air-tight vessel, of capacity somewhat larger than their dimensions, and for this purpose it is lined near the top with hooks. The hides are hung at regular [illegible] and kept distended by

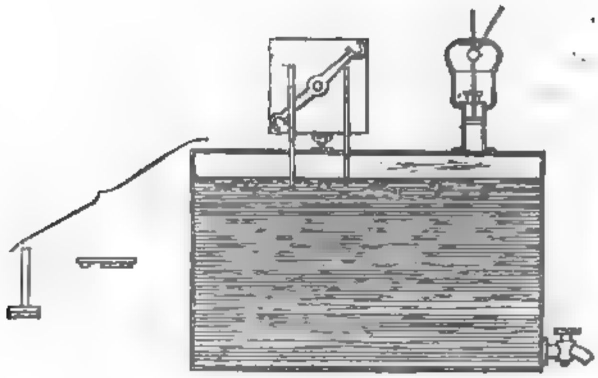
means of weights attached to their lower ends. In the upper portion of the vessel, or vat, is an opening with a movable cover, for the entrance of the workman. In the side and near the top, is a tube with a stopcock and coupling screw, for connecting with an air-pump; and in a corresponding position on the opposite side, is a similar tube for the admission of air, to create external pressure as may be required. The tanning liquid having been introduced until it reaches above the hides, the vessel is hermetically closed, and then exhausted of air by means of the air-pump. As soon as a vacuum is obtained, the contents of the vat are left in repose for a day and night, after which the tanning liquor must be drawn off, and the apparatus allowed to remain empty for two or three hours, to permit the entrance of the air. This manipulation is repeated several times, or until the hides are sufficiently tanned. The ooze must be renewed after each exhaustion of the vessel, and the first liquid should be weak, but, as the operation proceeds, its strength must be gradually increased.

This means of promoting hydrostatic pressure, by the aid of a vacuum, really accelerates the impregnation of the hides with tannin; and the process is said to be eligible, both as regards quality of leather, and economy of time and labor. The air being withdrawn from the pores of the skin, its resisting action, which prevents the rapid penetration of the ooze into the skin, is overcome.

Poole has announced a vacuum process, very similar to the preceding, except that the preliminary treatment in the lime liquor is also accelerated by atmospheric pressure. The prepared hides are then tanned as by Knowlis's method, and ultimately dried in an exhausted chamber, which is traversed by pipes heated with steam.

The apparatus which he employs, is shown by Fig. 93, which exhibits the vat from which the air is ex-

Fig. 93.



hausted by means of the air-pump, seen above it. The trap-door is held down, when closed, by the bar, which is fastened by screws and nuts.

Instead of having an air-pump attached to each vat, a central one, connecting by tubes with all the vats, can be substituted; or, still better, a movable one may be employed, which can be accurately adjusted to each separate vessel.

A space of from six to eight inches between the surface of the liquid, and the top of the vessel, will be quite sufficient room for the evolution of air bubbles which occurs from the former when the vacuum is being formed.

The hides are stretched upon wooden frames, and suspended vertically in the vat, free from contact with each other, and there left undisturbed until the completion of the process.

At the end of forty-eight hours, during which the vacant space in the upper part of the vessel has been kept exhausted, the liquid is drawn off through a stop-

cock in the bottom, and the skins exposed to the air for half an hour in winter, and quarter of an hour in summer, before the vat is refilled with a stronger tan-liquor than that first employed. After a like interval, the operation is repeated a third time with liquor of increased strength; and so on until the tanning is completed.

In this improved method, the skins being properly placed in the vats, are first exposed to the action of lime-water under a vacuum, so as to deprive them of hair. The second bath consists of weak tan infusion, soured by sulphuric or muriatic acid, for the purpose of *raising* them, the operation being conducted as before, and as in all the succeeding ones by the aid of the vacuum. The third bath is composed of tan-liquor, also of a strength of one-fourth of a degree. As this will probably be reduced by its loss of tannin, to one-eighteenth of a degree, the next bath may be increased in strength to that of a half degree, and so on with the succeeding ones, a larger amount of tanning matter equivalent to a quarter or fifth degree more of the areometer, being applied each time, until, in the final operations, the infusion rises to four, five, or six degrees of strength.

Hot water is to be used for leeching the tan.

The exhausted liquors can be kept for future processes less advanced than those for which they were employed, their strength being increased to the proper point by additions of tan.

The figure, referred to in the text, represents a wooden vat, but one built of masonry may be employed with an air-tight cement in the interior, and covered with a wooden or metallic top, so adjusted as to prevent the admission of air. As the expansion of the pores of the skins would be prevented by atmospheric pressure in the earlier part of the process, it must not be employed until

near the completion of the tanning, or the last three liquors.

The vat may be left open for twenty-four hours; and this exposure to air may be extended, during the last bath, to forty-eight hours.

From twenty to twenty-five days are generally sufficient for tanning calf-skins by this method, and thirty-five days for the thickest ox or cow hides.

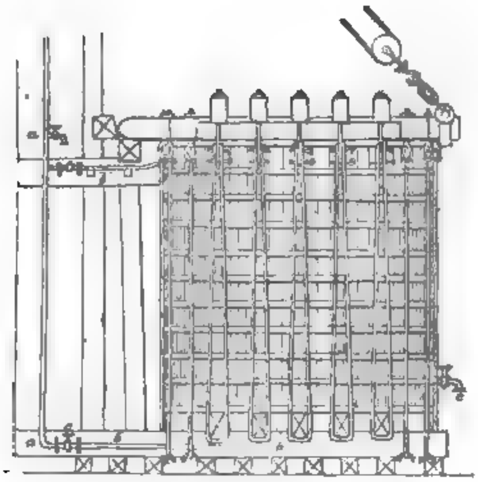
HANNOYE'S PROCESS.

Another method, analogous in principle to the preceding, consists in producing an equable and active filtration of tan-liquors through the skins, while they are exposed to pressure, the kind, temperature, strength, and mode of employment of which can be varied at will. For this purpose, the filter-press of Real, with some modifications, is made use of, not merely with the intention for which it has before this been employed, of extracting the active principles of bark, but as a direct agent in the tanning process itself; the skins being stratified in it with layers of bark, and the extraction of the tannin, and the absorption of it by the skins, being both effected under pressure, and without contact of air. The apparatus, which has been prepared upon the principle of the filter-press, is provided like it, with a tube having air-tight joints, by means of which a forced and uniform filtration is effected by the pressure of a column of fluid, and the tube is of such a height that the pressure can be increased or diminished at pleasure by altering the height of the column, while the character of the operation can be varied at will by the employment of different fluids. The pressure of the column of fluid can be directed alternatel[illegible] r the upper or lower sur-

faces of the skins, by means of tubes provided with stopcocks, and entering the vessel at the top and bottom.

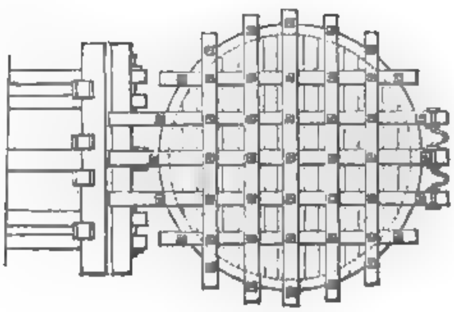
The inventor claims this new application of the principle of the filter-press, as being entirely original, and asserts that, by the employment of it, he has been able to arrive at a perfection, rapidity, and exactitude of the method of tanning, which have not been attained by any other process.

Fig. 94.



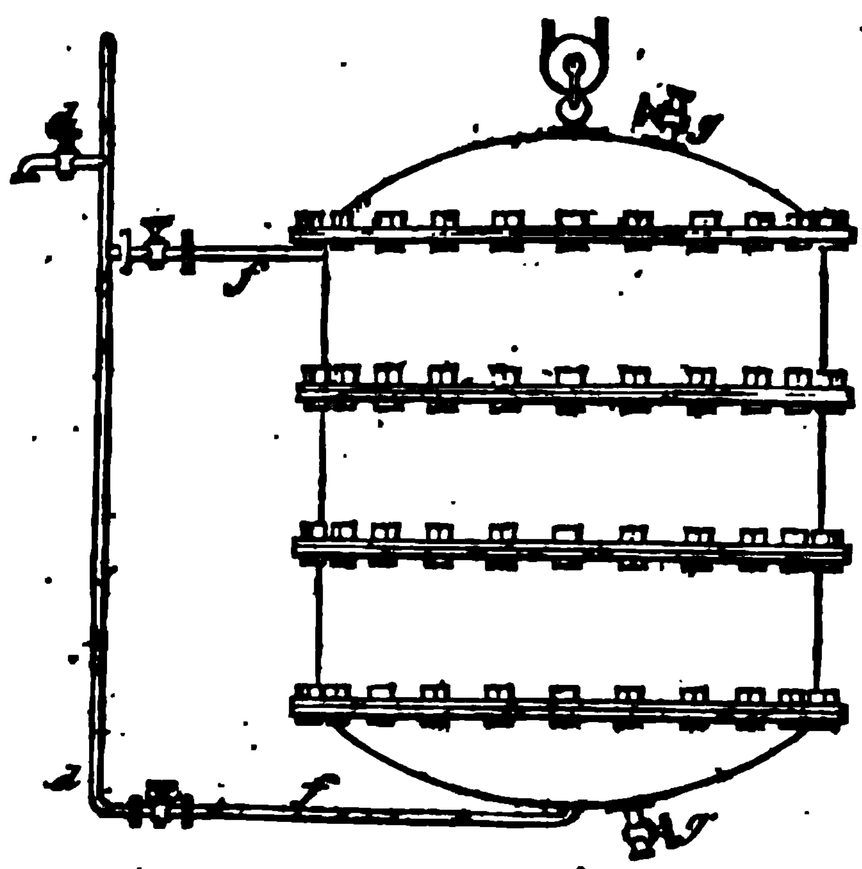
Figs. 94, 95, 96. Vessels of a cylindrical or square form, of a suitable capacity to hold the number of skins

Fig. 95.



intended to be operated upon, and which are capable of resisting a considerable pressure. A tube *a*, *a*, Fig. 94,

Fig. 96.



is attached to each, and is proportioned in height to the mode of making pressure which is to be adopted, whether it be that of a column of watery fluid, of mercury, or of the hydraulic piston. Branch-pipes, *b*, *b'*, connect this tube with the upper and the lower part of the reservoir, and the opening of one or the other of the stopcocks upon them, causes the pressure and consequent infiltration of tan-liquor through the skins to take place either from above downwards, or in the opposite direction. A pipe with a stopcock *e*, allows the liquid within the vat to escape.

"The reservoir may be composed of different materials. It may be constructed of solid masonry, covered in its interior with lime cement, over which a coating of tar or of some resinous substance is placed, so as to defend the leather from the action of the lime. It may be made of wood, lined with sheet-lead; zinc or copper, well soldered in all parts; or may be composed of cast-iron, lined

throughout with lead or zinc, so as to prevent the injurious effect of oxide of iron. upon the leather. In either case, the rim of the neck of the vessel consists of a solid plate or disk of metal, firmly attached to it, and a disk of thick leather is interposed between it and the top or lid, which is tightly fastened down by means of screws and nuts upon the plate. This top may consist of thick wood or of metal plate, also lined on its lower surface with sheet-lead or zinc. The copper or leaden tube *d*, *d*, for the column of fluid, is from one to three inches in diameter, and is connected with the vessel by two tubes, *f*, *f'*, one entering it below the lid, the other at its base. By opening the stopcock upon the upper tube, the pressure of the fluid is made upon the upper surface of the skins, and in the opposite direction by opening that upon the lower tube. Two other cocks, *g*, *g'*, the one proceeding from the lid, the other from the lower part of the reservoir, conduct the liquid which has traversed the skins into a suitable receptacle, the upper one being left open when the pressure is from below, and the lower one when it proceeds from above. The skins are stratified in the vat between beds of tan; water alone is usually employed for the pressure upon its contents, and for the extraction of the tannin, and the cocks for the egress of fluid are only left so much open as to allow it to escape drop by drop.

"Calf-skins may be tanned in twenty days by this method, and ox-hides in sixty days, but the tanning may be much expedited by the following arrangement. Instead of simply stratifying the skins with layers of bark, a framework of wood, with an open space in its interior, rather smaller than the skins, is placed upon each one. The interior of this frame is filled with tan, another skin is extended above the frame thus

filled, and is in turn surmounted by other frames and skins arranged in the same manner. To prevent the fluid from being forced through the spaces between the outsides of the frames and the walls of the vessel, these are filled up with mastic, or some impervious cement like the *fatty lute* of chemists, or a mixture of tallow and rosin. A similar application of lute is made around the edges of the skins, and the weight of the tan and frames soon makes the cemented parts perfectly tight.

"After each tanning is completed, the mastic or luting can be taken off and used for a similar purpose again. Skins tanned by this last method are as perfectly prepared in a few days, as those which have been exposed in the pits for sixteen months."

DANISH PROCESS.

This rapid method of tanning, by which "dressing leather" may be made in two months, is practised in Brittany and elsewhere.

After the skins have been soaked, fleshed, freed from hair, and rinsed in the ordinary manner, they are colored by being barley and tan dressed like barleyed skins. They are then sewed up into the form of bags, apertures of about ten inches in length being left, through which they are filled with tan and water. These openings being sewed up, the closed sacks are forcibly beaten in every part, for the purpose of distributing their contents equally throughout. They are then deposited in pits which should contain sufficient ooze to cover them completely; these pits being four and a quarter feet in depth, the same in breadth, and from eight and a half to ten and a half feet long. When submerged in the pits, planks heavily weighted with large stones or weights, are

placed upon the skins, so as to press them down forcibly towards the bottom, and to increase the penetrating power of the infusion; and in order that they may not be unequally tanned on their different sides, these planks are removed three or four times a week, and the sacks are thoroughly beaten and changed in position.

Skins prepared in this way are supple and pliable like crop-leather, and have a finer color than strong leather, but they are thinner than those made in the ordinary way, owing to their not swelling up by the slow process of feeding, and to the pressure from within and without to which they have been subjected.

It is possible that an improvement of this process, which is now the old method combined with that devised by Seguin, may offer many advantages.

The external and internal pressure mutually assisting, must certainly promote the introduction of tannin and extractive matter into the tissue of the skins. It is, however, doubtful if the durability and other qualities of the product are equal to those of leather prepared by more tedious processes.

ROTCH'S PROCESS.

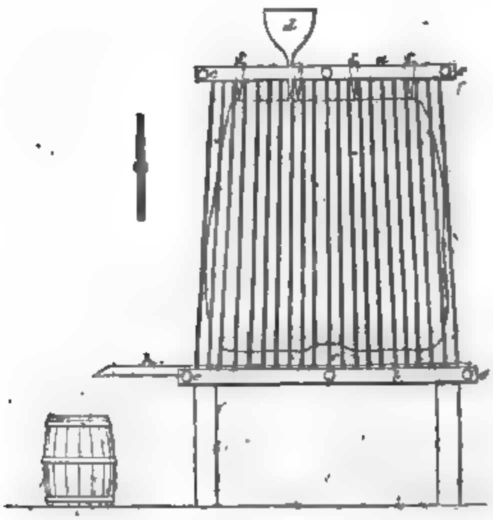
This method, patented in France in 1842, consists in causing tannin to penetrate the skins by moistening them with tan-liquor upon one side, while the water which passes through the pores is made to evaporate upon the other, by the application of artificial heat. By this means the greater part of the tannin remains in the leather, and the strength of the liquid which acts on the latter is being continually increased instead of diminished as in the old method. Leather can thus be pre-

pared as perfectly in ten days, as it commonly is in ten months.

The skins, previously limed in the usual manner, are soaked and handled in a weak tan-liquor, for the purpose of *raising* and coloring them. After being prepared and cleaned, they are then carefully examined, and if any holes are found, they are pieced and sewed. If it is desired, the skins may be cut into forms suitable for the purposes to which the leather is to be applied.

It is more economical to work two skins at a time, and those of equal size are closely stitched together at the edges, grain to grain, with tarred thread, and are suspended by cords, as seen in Fig. 97, to the pegs *s*, *s*, *s*, *s*,

Fig. 97.



which project from the bar *a*. This bar is the top of a wooden rack *a*, *b*, *c*, and there is a similar rack on the other side of the bag of skins, so that the latter can be compressed, not forcibly, but in such a manner as to make it retain its shape when full of fluid, between the

two ranges of uprights which are made to approach one another by screws *e*, *e*. An opening about an inch in length is left in the upper part of the bag, for the reception of the funnel through which the tan-liquor is poured in. The funnel may be conveniently placed in the neck or collar, seen in the figure along side of the rack.

Fig. 98 represents a section of a side view of the rack, and *s*, *s* the pegs upon the head of the rack, from which

Fig. 98.

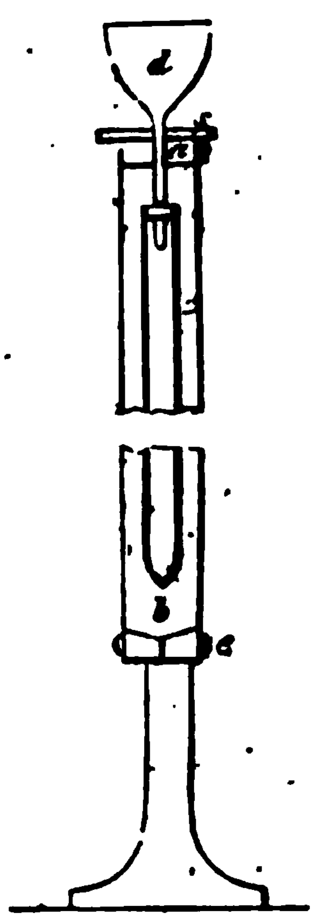
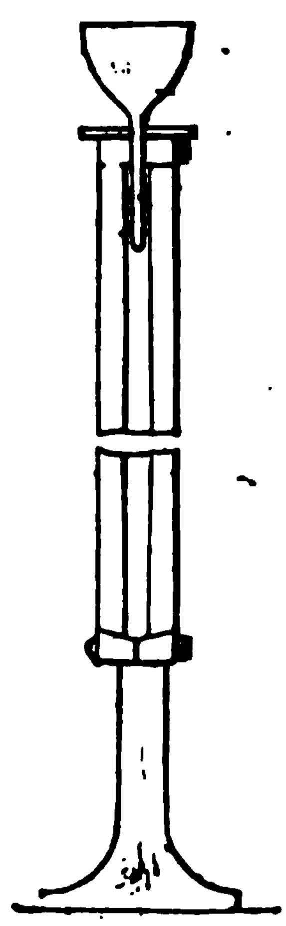


Fig. 99.



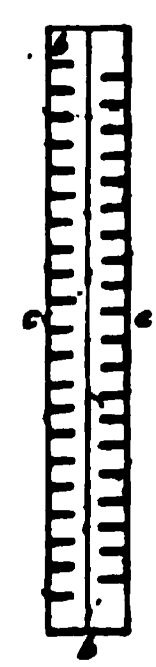
the bag of skins is suspended. The inner sides of the central bars composing the rack are hollowed out in the form of arcs of large circles, as seen in Fig. 99.

The skins being thus suspended, the cold tan-liquor is poured through the funnel until the bag is entirely full. After a time, which varies in length according to the thickness and permeability of the skins, their outside becomes moist, and the water which filters through, slowly drops into the gutter *h*, and flows into a receptacle placed below its spout. This liquid, as soon as it is cold, may be poured back into the bag so as to keep it con-

stantly full, and the supply of fluid is kept up from time to time in proportion as it is lost by evaporation and by draining off.

As soon as the surface of the skins becomes firm to the touch and equally moist throughout, the air of the room in which the operation is conducted, and which should be provided with a ventilator to allow the vapor to escape, must be gradually heated from 70° to 150° F., and kept at this latter temperature until the skins become firm and hard in every part, and assume a brown color, and until the liquor in the sacks ceases to diminish in strength. When all this occurs, the skins are thoroughly tanned. They are then taken from the frame, emptied of their contents, the borders which have been sewed are cut off, and the skins are dried and prepared as usual. During the continuance of the process, care should be taken to change their position frequently, so that the bars of the frame may not impress furrows or marks upon their surfaces, by pressing for too long a time upon the same parts.

Fig. 100.



The time required for tanning by this process, varies with the thickness of the skins, their changes of position, the strength of the liquor, the regulation of the heat of the apartment, and other circumstances which an experienced operator can readily appreciate.

Fig. 100 shows a section of the rack: *b*, *b*, lower part of the rack: *c*, *c*, bars of the two racks placed so as not to be opposite to each other.

S. SNYDER'S PROCESS.

Mr. Snyder, of Ohio, proposes to expedite the tanning of skins, by making their interior more accessible to tan-

liquor through numerous fine punctures made in the surface. He performs this pricking or *acupuncture* by means of an instrument with a surface of fine needle points, composed of from 100 to 300 to the square inch, according to the thickness and quality of the skin. A hand-instrument struck by a mallet is at present used, and with it a workman can prepare thirty or forty skins in a day; but a cylindrical machine, covered with steel points, could easily be made, which would prick a much larger number.

Some skins require puncturing on the flesh, some on the grain side.

It may appear paradoxical to recommend the perforation of an article, the chief desideratum of which should be its imperviousness to moisture; but the operation is performed while the skins are in the most soft, moist, and relaxed state, after they are worked out of the *bate*, or *grainer*; and when in this condition, the fibres separate before the points of the instruments just as other tissues do before a pin or needle. This soft and relaxed substance, full of indentations, after having been tanned and dried, will be found to be dense and contracted, and will not exhibit a trace of defect from the operation to which it has been subjected. These punctured orifices do not close, however, immediately after the withdrawal of the instrument or directly upon being tanned, but remain sufficiently open to admit the liquor into the interior of the skins, throughout the process, and until it is quite completed, becoming only gradually obliterated.

Better leather can be manufactured where this *acupuncturation* is resorted to than by other means, for the following reasons:—

1. Because the tanning is so accelerated, and the re-

newal of the tan-liquor necessarily so frequent, that it is not exposed to the air long enough to become acid. It is well known that acid has an injurious effect upon skins, relaxing their pores, expanding their fibres, enlarging the grain, and rendering the leather brittle; and since eight or ten days often suffice to acidify tan-liquor, it follows that the skins are frequently exposed to these injurious influences in the old processes, often for six or eight weeks at a time. These obstacles to tanning are avoided now, by a method which exposes a much larger surface to the action of the tan-liquor, so that, being rapidly exhausted of tannin, it requires a renewal of the tan-liquor before sufficient time elapses to acidify it.

2. Because by bringing the tannin at first directly in contact with the interior of the structure, the chemical change takes place there as rapidly as upon the surface; so that there is no occasion, as in the old method, for the surface to be exposed so long as to be rendered hard or brittle, in order to allow the solution to pass through it to the centre.

Although a very short time is occupied in tanning by this method, the process may be still further expedited by the application of hydrostatic pressure. For this purpose it is necessary to use a strong water-tight box, made as nearly as possible of the same shape as the skins, and having sides four to five inches in height, with a groove running all around. A layer of tan or other tanning material is deposited in the box, and is moistened with a small quantity of strong tan-liquor. The skin is stretched over this, with the grain side up, and another frame, exactly of the size of the first, with a continuous tongue, which presses the edges of the skin into the groove, should be placed on it. The two boxes

are held together by screws and nuts at the corners. A number of these boxes are then piled upon each other in a vat full of weak tan-liquor, each one being provided with a flexible tube or hose, rising from above the edge of the skin to the surface of the pit, so as to allow the egress of air.

CHAPTER XVIII.

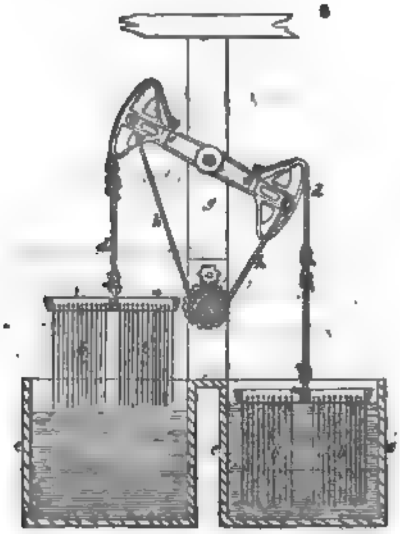
KEASLEY'S PROCESS.

Mr. Thomas Keasley, of England, has patented (January 11, 1845) a process founded upon his experience that alternate immersion and removal of the hides from the ooze, so as to allow frequent exposure of them to the air, shortens the time of tanning, and improves the quality and weight of the latter.

"The apparatus consists of a square, rectangular, or other conveniently shaped framing, from which the hides or skins are suspended vertically, in any convenient manner. The dimensions of the framing from which the hides or skins are suspended, must, of course, correspond with the size of the pit, so that the frame belonging to each pit, and with it the hides, may be raised or lowered at the discretion of the attendant. Each of these frames, containing the hides, is distinct and separate, and may be raised and lowered, separately, by manual labor, with the assistance of a windlass, if required; but it has been found more advantageous to connect two contiguous frames together, so as to make them counterbalance each other, and thus considerably diminish the labor of working them. A variety of means may be devised for carrying this idea into effect, but several plans are shown which will be found to answer the purpose.

"Fig. 101 represents a side elevation, and Fig. 102 an end elevation of one plan, in which the frames *a, a, a,*

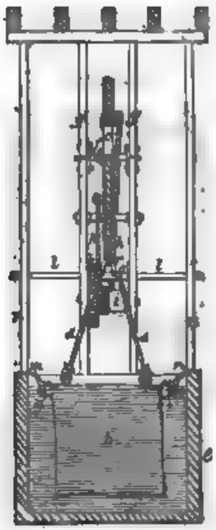
Fig. 101.



filled with hides, or parts of hides *b, b,* are suspended from the extremities of a vibrating beam or lever *c, c,* by means of chains or cords *d, d.* The tan-pits or vats *e, e,* are shown in in section, in both these figures. The beam or lever *o, c,* is mounted at *f,* in bearings firmly fixed in the framing *g, g,* for that purpose, and is worked up and down by means of chains or cords *h, h,* which pass round a windlass or barrel *i, i,* below, and are fastened at either end to the extremities of the vibrating beam. On the axle of the windlass, or barrel, is mounted a toothed wheel *j,* shown by dots in Fig. 101; it is driven by a pinion *k,* which is fixed on the shaft *l,* and is actuated by applying power to the said shaft, by means of a winch or otherwise. It will now be understood that as the pinion *k,* toothed wheel *j,* and barrel or windlass *i, i,* are

made to revolve, one end of the beam or lever *c, c*, will be raised, and the opposite end depressed, by one of the

Fig. 102.

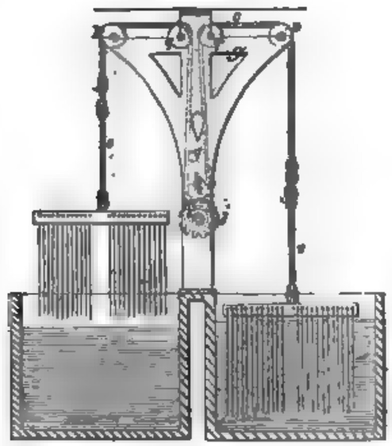


ropes passing over and the other under the barrel or windlass; and by this means one frame of hides will be lifted out of the tan liquor, while the hides on the opposite one are totally immersed. This operation may be reversed by turning the winch in the opposite direction. The ascent and descent of the frames is assisted by the forked guides *m, m* (see Fig. 102), which work against the vertical guide-rods *n, n*. At night, or at other times, when it is necessary that the hides on both frames should be immersed, this object is easily effected by unhooking from the suspending chains or ropes *d, d*, by means of the hook *r*, the frame that is already immersed, and then allowing the other frame to descend into the liquor, which it will easily do by its own weight. When one of the frames is raised, it is kept elevated by merely placing a

leather or wooden block between the teeth of the toothed wheel *j*, and pinion *k*, and thereby preventing them from revolving. This stop fully answers the purpose, and is more convenient than a pall and ratchet-wheel.

"Fig. 103 represents a side elevation of another plan

Fig. 103.



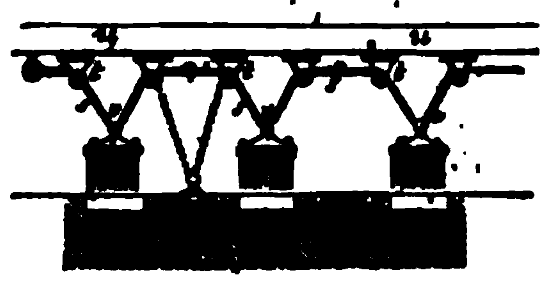
of carrying out the counterbalance principle. In this plan the vibrating beam *c*, *c*, is suppressed, and the suspending cords or chains *d*, *d*, and the working cords or chains *h*, *h*, are united together, and form the cords or chains *o*, *o*, which pass over pulleys *p*, *p*, at the outer extremities of the standards *g*, *g*, and down between two other pulleys *q*, *q*, and round the barrel or windlass *i*, *i*, as in the former instance. If, however, it is thought more desirable, the pulleys *p*, *p*, and *q*, *q*, may be attached to a beam, or the ceiling above, instead of the standards *g*, *g*. The barrel *i*, is furnished with a toothed wheel *j*, and is driven by a pinion *k*, precisely in the manner explained in reference to Figs. 101 and 102, and, therefore, no further explanation will be necessary.

"The patentee has also shown a means of raising the

frames containing the hides or skins, one at a time. In this case the pulleys are fastened, as before mentioned, to a beam above; the windlass or barrel being placed below.

"Fig. 104 represents another plan of raising the frames.

Fig. 104.



In this instance, several frames with the hides or skins suspended vertically, may be raised at one time, but not upon the counterbalance principle. The frames, with the hides or skins, are raised by means of a rope or cord *s*, *s*, *s*, which passes over pulleys *t*, *t*, *t*, affixed to a strong beam *u*, *u*, above. One end of the rope *s*, *s*, is firmly fixed to the beam, as seen in the drawing, and the other end is passed over the pulleys *t*, *t*, and round a windlass at the other extremity of the beam. The suspension cords of the frames are each furnished with a pulley or block *v*, constructed in such a manner that it may with facility be hooked on to, or detached from the rope *s*, *s*, according to whether it be required to raise the frames containing the skins or hides, or parts of skins or hides, out of the tan-liquor, or to allow them to remain immersed. It will be found most convenient to raise only one-half the number of frames at one time, leaving the remainder in the tan-liquor. In order to do this, the rope *s*, *s*, is brought down and every other frame hooked on to the rope; then, by turning the windlass or barrel, and causing the rope *s*, *s* to coil thereon, the frames, with the hides or skins, will be raised out of the pits, as shown in the drawing; the other

frames, which are not attached to the rope, remaining immersed. When the first lot of skins have been exposed a sufficient length of time to the atmosphere, the frames are lowered into the liquor again, where they are allowed to remain, by unhooking the pulleys *v*, *v*, which connect them to the rope *s*, *s*; and those which were before immersed, are now to be raised by hooking them in their turn, by means of their pulleys *v*, *v*, on to the rope *s*, *s*. If thought advisable, the counterbalance principle may be applied to this arrangement or plan of raising and lowering the frames, by merely employing an additional rope *s*, *s*, passed over pulleys exactly similar to the one shown in the drawing. One end of this rope, also, should be firmly attached to the end of the beam *u*, *u*, and the opposite end to the windlass or barrel; or, instead of two ropes, one only may be employed, by having it of sufficient length to pass from the end of the beam *u*, over the pulleys *t*, *t*, round the windlass and back again over similar pulleys *t*, *t*, to the end of the beam, so as to present a double rope, to one part of which the three frames 1, 3, 5, would be suspended, while the other frames 2, 4, would be suspended from the other part. Now if a double rope *s*, is employed, there will be no necessity to detach the frames from the ropes. The pulleys *v*, *v*, are merely made to run freely on the said ropes, and are not required to be constructed so as to hook on, as above-mentioned. It will now be understood, that if the counterbalance principle is carried out in this manner, one set of frames will be elevated, while the others are immersed; and the action of lowering one set will raise the other; that is, when the windlass is unwinding the rope to lower one set, it is at the same time winding up the other rope, and thereby raising those frames connected with it."

"Fig. 105 represents another plan of raising the frames. In this plan a travelling windlass is employed, which

Fig. 105.

may be made to traverse a railway, or floor, constructed on the top of the beam *u*, *u*, above the frames. When it is required to raise a frame, with its skins, or hides, the windlass is moved along the railway or floor immediately above the frame, and a rope with a hook at the end is let down to the frame, which is then attached thereto. The frame is then raised up by means of the windlass, until the skins are drawn out of the liquid, and are completely exposed to the atmosphere; in which position it is suspended by a hook *w*, firmly fastened to the beam *u*, where it remains until the manufacturer thinks it advisable to immerse the hides or skins again.

"Having raised one frame up, and suspended it from the hook *w*, the attendant releases the rope belonging to the windlass, and proceeds along the floor or railway with the windlass to another frame, which he raises and suspends from its hook *w*, in the same way. When it is required to lower the frames, and their hides, or skins, into the liquor, this must be done by means of the windlass, in exactly the same manner."

CHAPTER XIX.

TURNBULL'S PROCESS.

THE immediate and direct combination of tannin with the gelatinous tissue of skins, is retarded, or prevented, during the operation of tanning, by the following circumstances.

1st. The skins, when immersed in lime-water, absorb a considerable quantity of lime, which has the effect of rendering soluble and removing a portion of gelatine, or of so altering the nature of part of the structure as to render it incapable of combining properly with tannin; and so much of the lime is retained in the skins, that the tanner is prevented from acting upon them with perfect freedom.

2d. When catechu is employed for tanning, the leather made by it is very permeable to water, is loose and spongy in structure, and of a dark-red color. This condition is produced by the catechuic acid and extractive matters.

3d. When oak-bark and other substances used in tanning, particularly divi-divi and sumach, are macerated in water, exposure to the atmosphere causes the conversion of part of their tannin into gallic acid, which is a solvent of gelatine, and is consequently injurious in its action upon the skins, interfering with their thorough conversion into leather, and rendering the latter light, spongy, and inferior.

The chief object of Turnbull's process (patented in England, Sept. 6, 1844), is to obviate all these difficulties either by the complete removal of every trace of lime from the skins, or by obtaining depilation without the aid of lime.

Saccharine substances and pyroxilic or wood spirit possess the property of combining with and dissolving lime; and for the purpose of extracting the latter from the skins, he prepares a solution, consisting of fourteen pounds of sawdust, four pounds of coarse sugar or molasses, and sixty gallons of water; or it may be composed of sawdust alone, in the proportion of twenty-eight pounds to the same quantity of water. The skins are soaked for two or three days in this cold solution, which, during that interval, dissolves out the lime, and renders the skins more capable of readily absorbing the tanning material.

For the purpose of depriving the skins of hair without liming them, Turnbull immerses them for from five to ten days, first in a solution of sugar, which swells the tissue, loosens the epidermis, and allows the ready removal of the hair. He then soaks them in a solution of sea-salt, by the action of which this same cuticle is made to contract and separate from the true skin, without a corresponding effect being produced upon the gelatine. The hair can then be easily removed without the least injury to the gelatinous structure. The saccharine solution is composed of fourteen pounds of coarse sugar to one hundred gallons of water, and is maintained at a temperature of 50° to 80° F. The other solution is formed by dissolving fourteen pounds of sea-salt in one hundred gallons of water, and is kept at a temperature of from 70° to 100° F.

Turnbull has also used sepa-

rating the catechuic acid and other principles injurious to leather, which exist in catechu, and also of preventing the formation of gallic and ellagic acids, when galls, oak-bark, valonia, and divi-divi, are employed.

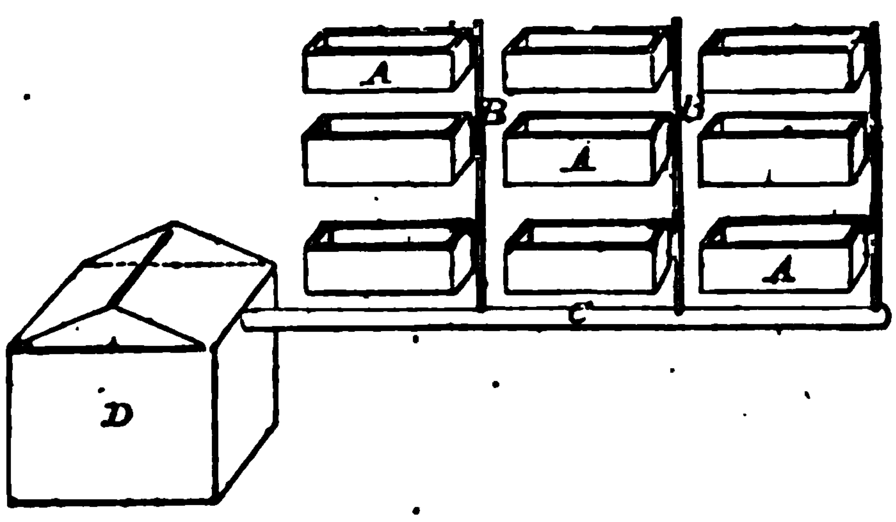
For separating tannin from the catechuic acid, the catechu is finely powdered, and exhausted of soluble matter, by repeated treatment with cold or milk-warm water. When the solution has cooled, it is to be strained through cotton: the catechuic acid and other substances injurious to leather being insoluble in cold water, are retained upon the filter. The liquid which passes through, being a solution of tannin nearly free from these principles, is much better adapted for preserving the sails of vessels, and tissues which are exposed to atmospheric influences, than an ordinary decoction of catechu. In order to prevent the conversion of the tannin of oak-bark and similar tanning substances into gallic acid, Turnbull reduces the materials to powder, and effects the tanning without exposure to air, as hereafter directed.

The skins are tanned in Turnbull's process: 1st, by the application of a force different from hydrostatic pressure or capillary attraction; 2d, by the employment of vats communicating with one another in such a way as to maintain a constant circulation of the tanning matter.

The first means consist in the application to tanning, of a principle similar to that which is exhibited in the phenomena of endosmosis and exosmosis, or the simultaneous passage in opposite directions through animal membranes, of fluids of different densities. For this purpose, "the hide or skin to be tanned is formed into a bag by sewing, and the oak-bark, which has been ground into powder, is introduced, in the proportion of two pounds to every pound weight of the wet skin, prepared as above; the opening through which the oak-bark has

been introduced is then sewn up, leaving only a small neck or aperture, through which the bag is filled with cold or warm water; and, when full, the neck or aperture is fastened by a flange and screw, so as to exclude the atmospheric air. The bag is then introduced into a box filled with tanning liquor, formed of terra-japonica, which has been freed as above described, from catechuic acid and extractives. The boxes are arranged in the manner shown at Fig. 106, A, being the tanks, or boxes;

Fig. 106.

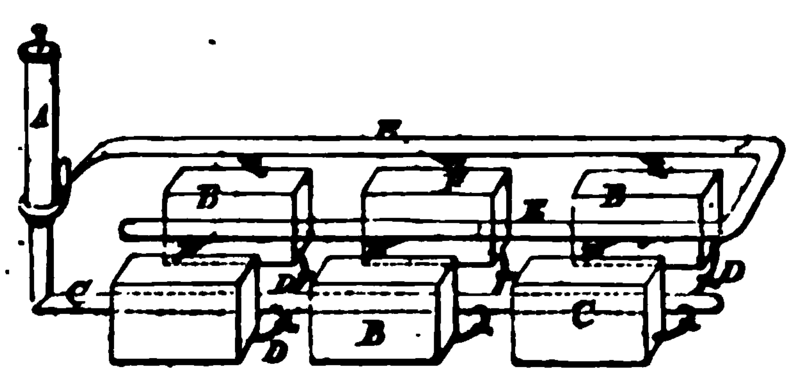


and B, the waste-pipes for carrying off the liquor, as it exudes from the hides, into the main pipe C, leading to the main tank or reservoir D. The purified terra-japonica is not injuriously acted upon by the atmosphere; and the tanning liquor, composed of oak-bark, being mixed inside the hide, or skin, and thus excluded from the action of the atmosphere, does not generate gallic acid. In order to increase the specific gravity of the liquor in the boxes, or tanks, and thus accelerate the action, sugar is added in the proportion of fourteen pounds to one hundred gallons of the mixture of terra-japonica. The two liquids, being thus separated, the process of *endosmosis* and *exosmosis* is secured, and the tannic acid passes rapidly through the skin, or hide, until it is perfectly tanned; the bags are turned occasionally, and when they become partially empty, by exudation, are filled again

with water. During the operation of tanning, it will be necessary to add to the weight of the liquor in the boxes, in order to keep up the action; this is accomplished by adding a small quantity of sugar to the mixture of terra-japonica. Valonia will rank next to purified tannic acid from terra-japonica, and may be used similarly to terra-japonica; ground valonia may be introduced into the bag, in the proportion of about one-half less than the oak-bark; divi-divi, sumach, and other substances containing tannic acid may be used in the same proportions as valonia. Terra-japonica ought to be introduced into the bag, after the impurities are removed, in the form of tan liquor, in the proportion of fifty pounds to the hide: one pound of terra-japonica is equal to four pounds of oak-bark.

"Fig. 107 represents the pits or tanks for tanning,

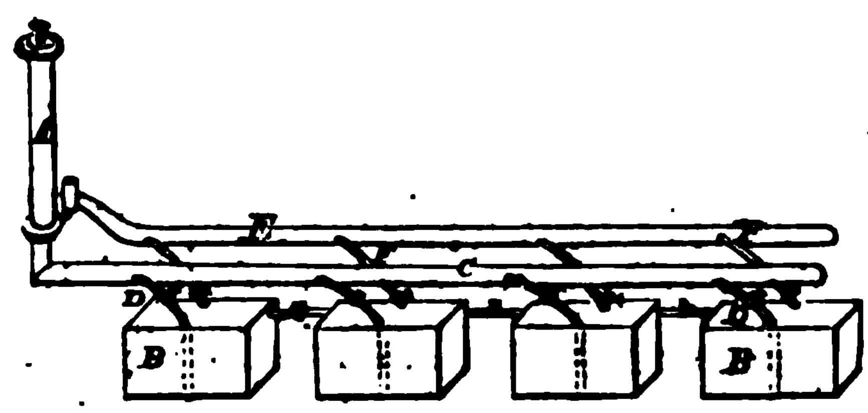
Fig. 107.



arranged so as to create and keep up a general and constant agitation and circulation of the tanning liquor. Into these pits or tanks is introduced a sufficient quantity of tanning liquor, composed either of terra-japonica, or oak-bark, divi-divi, valonia, sumach, &c., so as to leave room only for the hides and skins which are placed therein, one upon another, as in the ordinary mode of tanning; and the pits are then closed at top, so as to exclude the atmospheric air. The tanning liquor must then be put into, and kept in a state of constant agitation or circulation; this is effected by means of a suction-

pump, connected with the pits at the bottom and top. A is the suction-pump; B, B, the pits; C, suction-pipe; D, D, pipes leading from the bottom of the pits to the suction-pipe; E, main forcing-pipe, connected with the top of the pits by the pipes F, F; and G, G are pipes which connect the pits with each other at top, to prevent them from overflowing. By the action of the suction or forcing-pump, the tanning liquor is speedily extracted from the pits, through the pipes D, D, and C, and, at the same time, is forced again through the pipes E, and F, F, into the different pits; thereby keeping up a general agitation and circulation of the liquor. These pits or tanks may be constructed in sheds, or rooms, and placed one above another, and side by side; but if it is desired to sink the pits in the earth, they should be constructed and arranged as shown at Fig. 108, in which the same letters are used

Fig. 108.



to denote similar parts to those in Fig. 107. The operation of both arrangements is the same, with this exception, that, as in Fig. 108, the pits are sunk in the ground, the pipes, by which the liquor is withdrawn, are obliged to enter at the top, and descend nearly to the bottom of the pits.

"In treating terra-japonica, for the purpose of separating the tannic acid from the catechuic acid and other extractive and deleterious matter, the deposit, remaining in the cylinder or tank is at least fifty per cent. of the

quantity of terra-japonica dissolved; and it is capable of being purified, and rendered applicable to tanning. For this purpose it is placed in stoves or drying pans, heated to 160° F., and is exposed to the atmospheric air, and kept continually stirred, until it assumes the color and appearance of the original pulverized terra-japonica; this material being now filtered, will be found to yield nearly as much tannic acid as the terra-japonica did in the first instance.

"Hides and skins from which the lime has been extracted, or from which the hair has been removed without the use of lime, by the above modes described, may be tanned in the ordinary manner, by terra-japonica, purified as above, and by other ordinary tanning matter, with much greater facility than heretofore; and leather of greater weight, and better quality than usual, will be produced."

WARINGTON'S PROCESS.

This is an English method, patented March 16, 1841, by Robert Warington, and is said by the inventor to be applicable to the tanning of all kinds of hides and skins, whether dry, salted, or fresh.

"First, for soaking or preparing the hides or skins for unhairing. This I do by means of the carbonates of potass or soda; the latter, from its cheapness, is to be preferred, and dissolved in water, in the proportion of from one to two pounds of the carbonate to ten gallons of water.

"Second, for the preparing the hides and skins for unhairing, and swelling them at the same time, or for swelling them only; and this I do by various agents, which, for simplicity of explanation, I will divide into

three classes: first, baryta, potassa, soda; second, muriatic acid, nitric acid, and oxalic acid, and all other acids (except the sulphuric); and thirdly, vegetable matters, as the culinary rhubarbs, sorrel, apple marc, vine cuttings, and many others, which, from locality and other circumstances, may be economically employed. Of the first class, I prefer the use of soda, in the proportion of half a pound to one pound of dry carbonate of soda to ten gallons of water, and rendered caustic by about half its weight of fresh-burnt lime. Of the second class, I prefer, from its cheapness, the muriatic acid, which I use in the proportion of from half a pound to two pounds of the acid of commerce, of specific gravity 1.17, mixed with ten gallons of water. Of the third class, I prefer the culinary rhubarbs, bruised and mixed with water, in the proportion of from one to ten pounds of the rhubarb per gallon of water. As the details of the method of unhairing and fleshing the hides or skins when ready, is the same exactly as that usually followed, and is well known to all practical men, it would be useless to state them here.

"Third, for the use of the carbonates of ammonia in the operation of graining, and this I employ in the proportion of from half a pound to four pounds dissolved in ten gallons of water.

"Fourth, for the use of green vegetable matter bruised —as culinary rhubarb, bruised potatoes, &c.—or chemical agents, capable of deoxidizing or preventing oxidation—as gum, starch, certain compounds of sulphur, &c., which are to be mixed in small proportions with the tanning material—as barks, divi-divi—or extracts—as kino, catechu, &c. The proportion in which these agents may be employed are so various, and dependent on the tanning agent used, that it is impossible to give an accu-

rate proportion, but from one-hundredth part to one-tenth, supposing oak-bark to be employed.

"Fifth, for the use of bichromate of potass in solution, or diluted sulphuric acid, for the preservation of animal matter, so as to prevent putrefaction. When the bichromate of potass is used, I employ from one-eighth to half a pound to 100 gallons of water; and, in the case of sulphuric acid, from one-fourth to one pound to ten gallons of water. Into either of these solutions, the skins, or any other animal substances, in their moist state, are to be immersed and kept from the dust. I do not claim the use of any of the proportions hereinbefore given, as these must be regulated by the nature of the material operated upon, and the temperature of the air and season when it is employed."

CHAPTER XX.

H. HIBBARD'S PATENT PROCESS.

This process, patented in October, 1849, is said to possess, in an eminent degree, the advantages of economy of time and material. It is also applicable to the tanning of all kinds of skins, and produces leather of great strength and durability.

The inventor describes his process as consisting:—

"*First.* In the use of a composition of lime, wood ashes (or potash), and salt, for the purpose of removing hair or wool; also for the purpose of 'liming,' so called, instead of using lime alone, as in the old method. Lime and ashes have been used separately for the purpose of removing hair, wool, grease, mucus, and other impurities from skins; but lime alone requires several days, and, in cold weather, weeks, to effect these several objects; so that the muscular fibre of the skin is always more or less injured. On the other hand, ashes alone acts too rapidly, and would destroy the skins altogether; but when lime, ashes, and salt are combined in proper proportions, the salt modifies the action of the alkalies, and protects the skins from their caustic properties; so that the processes of unhairing and 'liming' are both rendered more expeditious and safe than by the old method. The texture of the skin is uninjured, and, consequently, the leather is much stronger.

"*Second.* In the use of a composition of salt, sulphuric acid (oil of vitriol), and sumach, oak, hemlock bark, or any other tannin for the process of tanning. The salt, sulphuric acid, and tannin being mixed together in water, in certain proportions hereafter mentioned, a portion of the salt is decomposed by the acid, forming sulphate of soda, and setting MURIATIC ACID free, which (*the muriatic acid*), being absorbed by the water, acts directly and rapidly on the skins, opening their pores, and preparing them for the tannin, which, being present also in the mixture, immediately and readily unites with the gelatine of the skins, forming leather more expeditiously and perfectly than by the old method of tanning." * *

PREPARATION OF THE SKINS.

"The skins *may* be prepared for the tanning process after the usual method. But I prefer and use the following composition, which I shall denominate—

Composition, No. 1.

Quicklime, fresh slacked	. .	½ bushel
Good wood ashes	. . . .	½ "
Chloride of sodium (*salt*)	. .	3 pints.

"N. B.—For the ashes may be substituted three to five pounds of potash.

"For removing the hair or wool, the above composition, No. 1, is to be mixed with water sufficient to make a thick paste, and applied to the flesh side of the hides in the usual way; the skins to be folded and kept at a temperature of summer heat. In a few hours they will be ready to pull.

"For the liming (or ashing) process, I use the same

composition, No. 1, mixed with a sufficiency of water in a vat, to immerse the number of skins proposed to be limed (ashed). One bushel of the mixture is about equivalent to one bushel of lime alone. The liming (or ashing) process may be conducted at a temperature of 40° to 60° F."

COMPOSITION FOR TANNING.

"For six dozen of full-sized sheep, deer, goat, or similar skins of similar size.

Composition, No. 2.

Chloride of sodium (salt) . .	18 lbs.
Sulphuric acid	2 "
Sicily sumach, or quercitron bark .	36 "
Muriatic acid	2 oz.
Dried clover	18 lbs.
Soft water	125 galls."

The sumach or dye-stuffs are first exhausted with water, and then the salt is added to the liquor, apportioned so as to insure perfect solution. Subsequently, the acids are added, and the mixture thoroughly incorporated by stirring.

The details of this process and the modifications necessary to make it applicable to the tanning of morocco, white, glove, and harness leathers, are given in a short treatise upon the subject by Dr. W. W. Reid, of Rochester, New York. Being a copy-right publication, we are not at liberty to extract or condense from it, and the reader must apply to the original source, if he should desire further information.

CHAPTER XXI.

LEPRIEUR'S PROCESS.

THIS process, published in 1833, consists of four operations, which, with some modifications, are those practised by all tanners.

1. The *rinsing*, or dressing in water, which comprehends the softening of dry skins, the washing, the separation of the hair, the fleshing, &c.

2. *The sugar of lead bath.*—The skins, having been well washed and drained, are deposited and left during ten or twelve hours in summer, and from twenty-four to thirty hours in winter, in a bath containing one pound one and a half ounces of acetate of lead for every six or eight skins, being in the proportion of one part of the salt to 1000 parts of water. The skins are then taken out and are again placed in a similar bath, in which they are allowed to remain for from twelve to twenty-four hours, care being taken to handle them every three hours during each immersion. They are then carefully rinsed in running water. The author believes that the combination of the lead salt with the albumen of the skins gives them a solidity, and freedom from looseness of texture which they would not otherwise possess.

3. *Tan-liquor baths.*—The author, after contending that the *raising* of skins is not essential, and that, if considered necessary, it can readily be effected by adding acid

to the first infusions, gives the proportions of one part of tan for ten parts of dry hides, with enough sulphuric acid to impart a distinct acid taste, as being all-sufficient for the purpose.

FIRST SERIES OF TAN INFUSIONS. *First bath.*—This is composed of 22 pounds of tan for every 110 pounds of hides, infused for twenty-four hours in enough water to cover but not to completely sink them. To this mixture, a quantity of strong *sour* ooze, or else from 9¼ to 9¾ ounces, by weight, of sulphuric acid, at 66° B., are added, and if, after maceration for twenty-four hours, the liquid is not sensibly acid, more is poured in, if it is desired to effect the *raising* by means of it.

In summer, the hides should not be kept in this bath more than thirty or forty hours, since, at the end of that time, it is exhausted, and disposed to putrefy, from the quantity of animal matter then contained in it. In winter, this tendency being retarded, they may remain in it a day longer.

Second bath.—33 pounds of tan for 110 pounds of dry leather are deposited in this bath, which is to be acidified in the same way as the first. The skins should be kept in it for thirty-six hours, after which time they are taken out to drain, reimmersed for thirty hours more, and again drained. On account of the animal matter contained in the infusion, it is now no longer serviceable except as a putrid ferment for new infusions.

Third bath.—In this bath, 44 pounds of tan are used for the above-mentioned weight of skins, and not more than 9½ ounces of sulphuric acid are added, if the previous *raising* has been considered sufficient. The skins should be taken out at intervals, as in the former operations, washed in water, drained, and replaced. The author remarks that if, after a continuance in the bath

of four or five days, it shows 3° or 4° by the acid hydrometer, the skins may be allowed to remain twenty-four hours longer; or, still better, the liquid may be used, in the same manner as the first bath, for thin skins, like those of the calf, goat, sheep, &c.

Fourth bath.—55 pounds of tan, the same mode of preparation (excepting the use of less water), the same acidification, and a continuance of the skins in it for six or eight days, are required in this fourth process. The skins, before being placed in the vat, are drained for eight or twelve hours, and afterwards are taken out at least three times, so that it may be ascertained that the liquor has not become too weak. If the degree shown by the acid hydrometer is four or five tenths, a fresh liquid is prepared, and the old one is reserved for skins which are undergoing the second series of baths. The author adds that it is better generally to deposit fresh skins in old baths, which they quickly exhaust, than in those more advanced.

SECOND SERIES OF INFUSIONS. *First bath.*—According to Leprieur, a new set of skins begins with the fourth bath of the first series of infusions, and will require 330 lbs. of bark, to tan them as completely as the others.

Second bath.—Since the fifth bath of the first series would not be disposed of in time to answer for the second bath of the second series, and would, moreover, be too strong, a new one should be prepared like that of Number 2.

Leprieur recommends after the fourth bath, to stratify the leather and tan alternately, interposing peeled willow twigs or strips of white wood, so that the surfaces shall be equally soaked.

FIRST SERIES. *Fifth bath.*—66 lbs. of tan for 110 of hides. The latter kept in the vat for from six to eight

days, should be taken out, drained, and replaced three or four times during this period. If strips are placed between them, it will be sufficient to cover the last layer of tan with the infusion, to the height of half an inch.

SECOND SERIES. *Third bath.*—The fifth bath forms the third of the second series.

Sixth bath.—Consists of 66 lbs. of tan to 110 lbs. of hides, which remain in it about ten days, and are taken out and drained at intervals of two or three days. It is well to observe that when the infusion marks more than five or six of the acid hydrometer, the skins should be taken out, and the bath reserved for others which are less advanced in preparation.

Fourth bath.—The sixth bath, like the fifth, not being unoccupied soon enough to answer for the fourth of the second series, it is necessary to prepare it with fresh materials, like No. 4. It will then be the sixth of the first series under the denomination five.

Fifth bath.—There being no further danger of putrefaction to the hides, they can now remain in this bath until the fifth bath of the first series is fully prepared.

Seventh bath.—Consists of bark 88 lbs. for 110 lbs. of hides, which should remain in it for twelve or fifteen days, or until the liquid marks no more than from six to seven tenths by the hydrometer. After that time it will serve for the second set of skins. When the hides are taken from this bath and cut, the sections will show a well-tanned surface, but an unchanged interior.

Nearly fifty days will now have elapsed since the skins were placed in the first bath, and for every 110 lbs. of hides, 385 lbs. of bark will have been consumed. Supposing now that 1100 lbs. of tan are used in the ordinary method of tanning that weight of leather, there

will still remain 717 lbs. to be used in the pits, to make the expenditure of material the same in both processes.

Sixth bath.—The seventh bath of the first series is the sixth of the second; but the author regards it as a matter of indifference, whether the hides are at once deposited in the vats, or are again exposed to a bath of 110 lbs. of tan to an equal weight of leather.

TANNING IN THE VATS.

Leprieur uses tan well mixed with water, to which sulphuric acid has been added in the proportions before mentioned, so as to saturate the potassa of the bark. A layer of this mixture is deposited upon the bottom of the vat, a hide is spread out upon it, and the stratification is continued in this way until the vat is filled. This last hide is covered with a stratum of one inch of the mixture; a sufficient quantity of water to rise above the surface is then thrown in, and weighted planks are placed over the whole, to prevent the skins from floating. After the commencement of the process, the liquid in the vat should be tested every three or four days with the hydrometer, so as to ascertain if any diminution of strength has taken place. In that event the skins should be taken out and deposited in another vat. For the purpose of being more explicit in regard to the determination of the density of the infusion, Leprieur adds: "Taking into consideration the fact that 110 lbs. of good tan, furnish 1320 lbs. of infusion, marking one degree of the strong hydrometers, and ten or twelve tenths of the acid hydrometers after forty-eight hours, it will be easy to ascertain day by day from the diminution in density of the liquid, how much of the tanning principle has been absorbed by the skins. When the

infusion is thus diminished in strength by one-half, it will still serve for other processes, and another supply of tan can be given."

We abstain from referring to the accessory circumstances which will more or less affect this absorption, our intention being only, as throughout this account, to make known the details of the author's process, as given by himself.

FIRST TANNING IN VAT.—100 parts of tan for every 100 parts of hides, are used in the first vat, the water being mixed as before, with rather more than nine ounces by weight of sulphuric acid. The skins are to be retained in this first vat from twelve to fifteen days; and besides the testing of the liquor by the hydrometer, they should be cut from time to time, so as to ascertain what progress the tanning has made. If considerably advanced, and if the liquid is reduced to five or six tenths, the vat should be changed.

SECOND SERIES.—The contents of the first vat are not exhausted, but furnish a strong infusion for a sixth bath for the second set of skins.

SECOND TANNING IN THE VAT.—Consists of exposure of 100 parts of skins, with 120 of tan, prepared like the preceding, for about fifteen days.

First Tanning in Vat.—The preceding, or second tanning of the first series, forms the first tanning of the second series. The skins taken from the first tanning are then exposed to the second.

Third Tanning in Vat.—Consists of exposing 100 parts of hides, with 130 of bark, for from fifteen to twenty days, the preparation being the same as before. The hides taken from this vat should be carefully examined, as the thinnest ones are probably tanned.

Fourth Tanning.—This is the second of the second

series. 140 parts of tan, for 100 of hides are used for from fifteen to twenty days, the preparation being the same as before.

Third Tanning.—The preceding, or the fourth of the first series, serves as the third for the second series.

Fifth Tanning.—In this 100 parts of hides are exposed to 160 parts of tan, for from twenty to thirty days, this quantity of 176 lbs. completing the 1100 lbs. used for the first series. This last tanning is seldom considered necessary for good skins, or where the bark is of good quality.

Fourth Tanning.—This is the fifth for the first series. If at the end of twenty days the tanning is not found to be already completed, from fifteen to twenty days more may be allowed to elapse before the leather is taken out, this being the last tanning of all.

If it should be necessary to add 220 lbs. more of tan to the amount already used, 220 lbs. of leather would be completely tanned, by means of 1650 lbs. of bark.

In order not to lose time in the series of complicated operations of this process, the fresh baths and vats should be prepared as soon as the operations of the preceding ones are nearly concluded.

REVIEW OF THE QUANTITIES OF TAN EMPLOYED IN THE PRECEDING PROCESSES FOR TANNING 220 POUNDS OF LEATHER.

First Series.

Tan for baths . . .	385	1101 lbs.
Tan for pits . . .	716	

Second Series.

Tan for baths . . .	88	264 lbs.
Tan for pits . . .	176	
		1365 lbs.

According to Leprieur's account, strong and supple hides are tanned by his process, in from 100 to 130 days, middling ones in 150 days, and refractory ones in about 180 days. Sometimes a sixth tanning is required, which will not much increase the duration or expense of their preparation.

CHAPTER XXII.

TANNING WITH EXTRACT OF OAK-BARK OR CATECHU.

Burbridge's Process.—Burbridge regulates the strength of the extract by a hydrometer, especially adapted to the purpose, which he calls a *barkometer*. He commences the process with a weak solution at 3° of his meter, and gradually increases its force, changing it three times a week, until a strength of 15° or 20° is arrived at.

In the old method, tanners are usually satisfied if forty parts, by weight, of hides in the raw state are not diminished more than one-half after a year's exposure in the vats. But an equal quantity, tanned by Burbridge's process, is found to weigh twenty-four parts after three months, which has convinced him that the longer exposure is detrimental to the leather. He does not consume more tan than is used in the slower methods, four parts being generally sufficient to tan one of skins.

Burbridge has also proposed to substitute the *terra japonica*, or *catechu*, for oak-bark. Mr. J. Dauks reported, in the year 1812, to the East India Company, that catechu contained ten times as much tanning matter as oak-bark, and the Company, induced by his representations, made every effort to encourage its use; but all attempts, by them and by government, to make it take the place of the substance in common use have failed. It certainly could be procured at a much lower price

than the equivalent amount of oak-bark; therefore, some practical objection to its use, of which we are ignorant, must have prevented its adoption.

John Burbridge proposes to reduce the time of tanning sole leather to three or four months, by the use of oak-extract, which he prepares without loss in ten days.

CHAPTER XXIII.

HEMLOCK TANNING.

The hemlock forests of New York and northern Pennsylvania are very extensive, and the readiness and cheapness with which the bark may be obtained have brought it into general use, in those States, as tanning material. It may be employed alone, or in combination with oak-bark. The Hon. Zadock Pratt, who is the most skilful and experienced manufacturer of leather in the United States, has kindly furnished me with the following particulars of his tanneries at Prattsville, N. Y., wherein it is used to the extent of 6000 cords annually. His statement is so full and comprehensive, that we give it in the original language.

"My tannery is an immense wooden building, 530 feet in length, 43 feet in breadth, and two stories and a half high. Adjoining the centre of the tannery, are two bark sheds, 125 feet long by 24 wide; and, near the east end of the tannery, a store-house 40 by 60. On the same level, 100 feet from the tannery, are some dozen houses, built in a line parallel with the tannery, for the convenience of the workmen. The main road through the village is about twelve rods distant, and parallel with the tannery. Within the area of the tannery are contained 300 vats, tanning over 60,000 sides a year, with conductors to draw the liquor to the pump, affording

about 46,000 cubic feet of room for tanning purposes, and 7640 in the beam-house. A large wing, 40 by 80 feet, extending over the stream, contains twelve leaches, six of them furnished with copper heaters, containing about 13,000 feet, and also the back loft, through which, in the course of the year, passes more than 6000 cords of bark. The mills through which it is ground are capable of grinding over a cord of bark per hour; and it has connected with it a pump of sufficient capacity to deliver 1000 feet of 'ooze,' or water charged with tannin, in 30 minutes. The beam-house contains 30 vats, equivalent to 7640 cubic feet. It has connected with it three hide-mills,* for softening the dry Spanish hides, and two roll-

* HIDE-MILLS, OR FULLING-STOCKS.—These machines are employed for softening the hides, and thus, by bringing them as nearly as possible to the fresh state, to facilitate the after processes of depilation and tanning.

Monier and Ray's Mill.—Skins with the hair on are first soaked in cold water for forty-eight hours, and are then subjected to the action of the machine for an hour and a half; exposure for which time is generally sufficient to render them pliable. Eight or ten skins, according to their size and thickness, are generally contained in the apparatus. The water is then allowed to drain off, a sufficient quantity of cream of lime is poured in, and the skins are beaten again for four hours, when they are taken out and piled up. After having been left to drain for five hours in this position, they are again fulled for a time in the machine, and then are deprived of their hair and fleshed by the workmen. They are then beaten for an hour and a half in the machine, and cleaned and scraped with the slate. In order to remove the lime, some of which still remains attached to the skins, they are now soaked in water containing one-hundredth part of sulphuric acid, and, after being constantly stirred about in this liquid for an hour, are washed and rinsed in running water.

This method of preparing skins for tanning, dispenses with the laborious manipulations to which they are commonly subjected, and preserves their quality, not injured as they are in the old way, by the hands of the workmen. It also presents the additional advantage, that they do not require the long exposure to the action of lime, which is so apt to injure their tissue.

ing machines, capable of rolling 500 sides of leather per day. Outside of the building, but connected with the

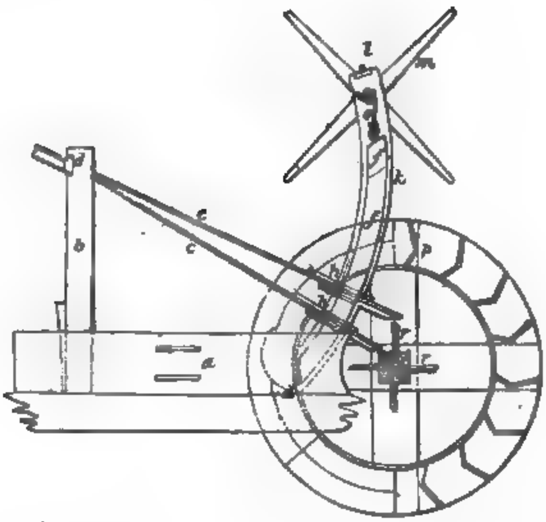
Description of this machine, as it has been improved, enlarged, and prepared for the fulling of both small and large skins.

Fig. 109. Side elevation.

Fig. 110. Front view.

Fig. 111. Plan.

Fig. 109.



(*a.*) Trough in which the skins are placed.

(*b.*) Upright rising above the trough, and supporting the levers (*c*) near its upper extremity, where they are attached to a crosspiece (*d*).

(*e.*) Wedge pressing upon the upright (*b*), and giving it the necessary inclination.

(*f.*) Mallets or hammers attached to the lower end of the levers (*c*), and acting upon the skins in the hollow part of the trough (*a*), formed by the curved line seen at (*g*).

(*h.*) Wedges arranged so as to keep the mallets inclined in the proper direction to the curve (*g*) of the trough.

(*i.*) Other wedges serving the same purpose.

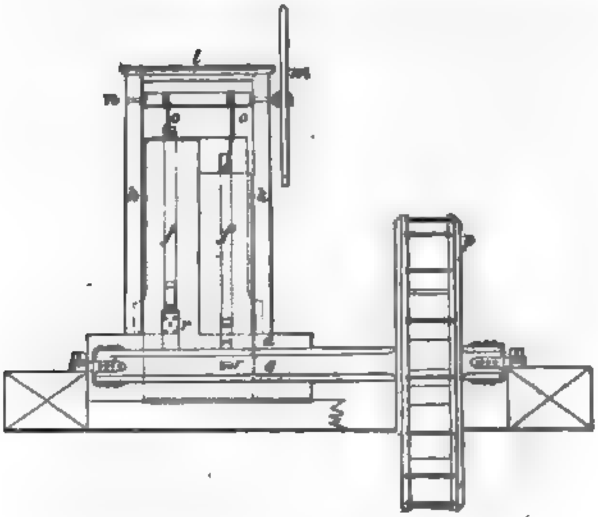
(*k*). Two curved uprights rising above the trough and preventing the mallets from swaying.

beam-house by an underground communication, are eight stone sweat-pits, with pointed arches and flues. The

(*l*.) Crosspiece uniting the uprights (*k*).

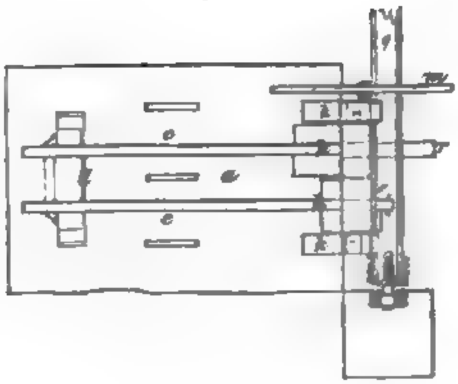
(*m*.) Vertical wheel, or turnstile, with four arms, the axis (*n*) of which turns in the uprights (*k*), and is the shaft for the cords (*o*) which keep the mallets suspended.

Fig. 110.



(*p*.) Wheel turned by a stream or fall of water, its axle (*q*) carrying cams (*r*), which, in turning, alternately raise and lower the mallets (*f*).

Fig. 111.

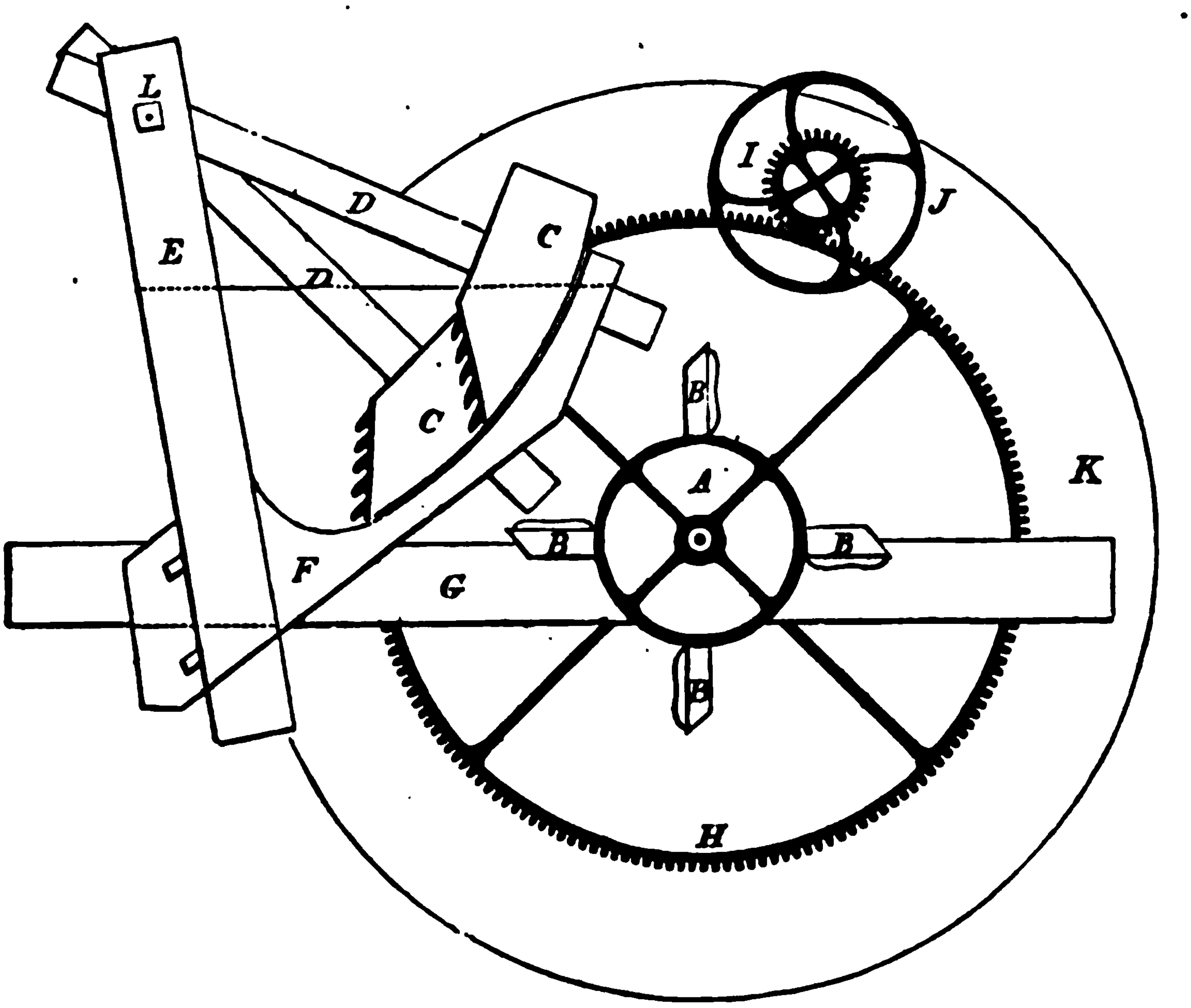


pins are of the most approved size, being in area 10 feet by 14, and in depth 8 feet, with a spring of water at one corner.

There are some recent improvements, in Monier and Ray's process, which refer to pressing the skins, to the liquid in which they are *raised*, and to their liming.

Since pure water is a solvent, and is capable of injuring the quality of the leather, if left for too long a time in contact with the tissues of the skins, it is evident that, if the latter are entirely deprived of it before being placed in the infusion of bark, their complete tanning will be much facilitated and hastened. To secure this desirable result, after having been perfectly cleaned, scraped, and rinsed, they are to be subjected to the action of a powerful common press, which deprives them of nearly all their free watery contents. After this compression, they are then deposited in a vat containing weak tan infusion, are left in it for six days, are taken out and again pressed, and then deposited in a vat containing a stronger infusion, which is kept of uniform strength for a period of ten days. At the end of this time they are taken out, pressed

Fig. 112.



"Since I first commenced business, the gain of weight in converting hides into leather, has been increased nearly 50 per cent. That is, that from a quarter to a third more leather can now be obtained from a given quantity of hides, than at the time when I learned my trade at my father's tannery, conducted in the old-fashioned way, some 40 years ago.

"The great improvement in weight seems to have been gained by the judicious use of strong liquors, or 'ooze,' obtained from finely-ground bark, and by skilful tanning.

"The loss and wastage upon hides, from hair, flesh, &c., may be estimated at from 12 to 15 per cent. In order to produce heavy weights, the hides should not be reduced too low in the beam-house, and should be tanned

for the last time, and then placed in pits in the ordinary way, to remain in them for from two to three months, according to their thickness and size. Instead, however, of filling up the pits with pure water, or a weak tan liquor, which may both retard the operation and injure the skins, it is recommended to use a concentrated infusion of bark alone.

The fulling-mill used in the American tanneries is similar in construction to the preceding. The drawing (Fig. 112), for which we are indebted to the Messrs. Wiltse, machinists, represents the machine upon the scale of a quarter of an inch to the foot. If driven by an engine or by a belt, the wheels *H* and *I*, with the pulley *J*, are used. When water-power is employed, they are replaced by a water-wheel *K*, built upon the same shaft *A*. The width of the wheel should be four feet, and it should run at the rate of twenty revolutions per minute.

The hammers *C*, of the mill are secured in the arms *D*, which, by coming in contact, at their lower ends, with the tappets *B*, receive motion. The upper ends of the arms are hung, and work on the nozzle-pin *L*, which passes through the back-piece *E*, of the stock-frame *E F*.

Isaac S. Hershey (*Patent Office Report*, 1849, p. 316) has patented a machine for softening hides, which consists of right and left revolving helical breakers or fluted rollers.

Either of these machines will perform work much more rapidly and satisfactorily than it was formerly done by the tedious and laborious process of treading the hides under feet.

quickly with good strong liquors, particularly in the latter stage of the operation. To green hides, particularly, nothing can be more injurious than to suffer them to remain too long in weak 'ooze.' They become too much reduced, grow soft, flat, and flabby, lose a portion of their gelatine, and refuse to 'plump up.'

"On the other hand, however, the effects of an early application of 'ooze,' that is too strong and too warm, to green hides, is very injurious. It contracts the surface, fibres of the skin, tanning at once the external layers so 'dead,' as it is termed, as to shut up the pores, and prevent the tannin from penetrating the interior. This renders the leather harsh and brittle. It will from this be seen that, in the question of the proper strength of liquor alone, there is room for the exercise of the greatest judgment and the most extensive experience. In the impossibility of adapting fixed rules to the innumerable variety of cases, nothing can be depended upon but the judgment of the practical tanner.

"In softening hides, and preparing them for the process of tanning, a great deal also depends upon the judgment of the person superintending the operation, inasmuch as the diversities in the qualities and characteristics of hides render it impossible to subject them to anything more than a general mode of treatment.

"In 'sweating,' the character of the hides, and the temperature, are essential, but ever-varing considerations. As a general rule, however, the milder the process of preparing the hides for the bark, the better. Unnecessarily severe or prolonged treatment is inevitably attended with a loss of gelatine, and a consequent loss of weight and strength in the leather. Too high a temperature is particularly to be avoided. In almost every lot of hides, particularly Oronocos, however, there are gene-

rally some that prove very intractable—resisting all the ordinary modes of softening. For such, a solution of ashes, potash, or even common salt, will be found to be beneficial; and peculiarly so in hot weather. As I have said, no precise rule can be given as to the length of time required for the preliminary process of soaking and 'sweating,' so much depending upon the qualities of the hides, and the temperature at which these operations are conducted.

"The following table may, however, be found useful in conveying an approximation to a definite idea of the practice in my tannery.

				TEMPERATURE.
SOAKING.	40°	50°	60°	70°
	Days.	Days.	Days.	Days.
Buenos Ayres hides . .	10 to 12	8 to 12	6 to 8	8 to 6
Carthagena and Laguaira .	8 to 12	7 to 9	5 to 7	2 to 3
SWEATING.				
Buenos Ayres hides . .	15 to 20	12 to 16	8 to 12	2 to 3
Carthagena and Laguaira .	15 to 20	10 to 15	6 to 8	2 to 3

"I would here remark that I changed the process from liming to sweating, for the sole leather, in 1836—the only change in tanning I have made for twenty years; and for heavy sole leather, it has been proved to be quite as good as liming if not better, and somewhat cheaper; besides yielding a greater gain of weight, and when well tanned, making leather more impervious to water. Liming and 'bating,' however, for upper and light leather, is preferable; and, if the same improvements had been adopted with the lime process, of strong liquor and quick tanning, it is not yet certain that the same results would not have been attained.

"Salted hides do not require more than two-thirds the time to soak; but generally rather longer to sweat. After

the hides are prepared for tanning, the next process is what is commonly called 'handling,' which should be performed two or three times a day in a weak 'ooze,' until the grain is colored. New liquors, or a mixture of new and old, are preferable for Spanish or dry hides—old liquor for slaughter. They are then, after a fortnight, laid away in bark, and changed once in two or four weeks, until tanned. Much care and judgment are necessary in proportioning the continually increasing strength of the liquors to the requirements of the leather in the different stages of this process.

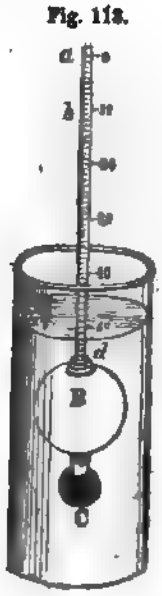
"The liquors should also be kept as cool as possible, within certain limits, but ought never to exceed a temperature of eighty degrees; in fact, a much lower temperature is the maximum point, if the liquor is very strong; too high a heat, with a liquor too strongly charged with the tanning principle, being invariably injurious to the life and color of the leather. From this it would seem, that time is an essential element in the process of tanning, and that we cannot make up for the want of it by increasing the strength of liquor, or raising the temperature at which the process is conducted, any more than we can fatten an ox or horse by giving him more than he can eat.

"I have mentioned the injurious effects resulting from too strong a solution of the active principle of the bark; on the other hand, the use of too weak solutions is to be avoided. Hides that are treated with liquor below the proper strength become much relaxed in their texture, and lose a portion of their gelatine. The leather necessarily loses in weight and compactness, and is much more porous and pervious to water. The warmer these weak solutions are applied, the greater is this loss of gelatine. To ascertain whether a portion of weak liquor

contains any gelatine in solution, it is only necessary to strain a little of it into a glass, and then add a small quantity of a stronger liquor. The excess of tanning in the strong, seizing upon the dissolved gelatine in the weak liquor, will combine with it, and be precipitated in flakes, of a dark curdled appearance, to the bottom. At the Prattsville Tannery, the greatest strength of liquor used for handling, as indicated by Pike's barkometer,* is sixteen degrees; of that employed in laying

* HYDROMETER.—A hydrometer is a convenient apparatus for ascertaining readily the density or strength of liquids. That referred to above has been styled by its maker (W. Pike, of New York) a *barkometer*, because it is specially adapted to testing the strength of bark lyes. Its form and the manner of using it are represented by Fig. 118. It is made wholly of glass; *a*, *d*, being the stem, inclosing a graduated paper scale; B, a spherical bulb; and C, a smaller bulb at its base, containing quicksilver or shot, which serves as ballast to retain the instrument in a vertical position in the liquid. The scale on the stem is equally divided into five or ten wide spaces, and each of these again subdivided into ten narrow spaces. The zero point of the scale is made by plunging the instrument in distilled water at 58° F., and adding mercury to the bulb until it sinks to nearly the top of the stem *a*. A solution of ten parts of bark in ninety parts of distilled water having been made, the hydrometer is then plunged in the liquor, and the point to which it sinks therein, say *b*, is carefully and accurately marked upon the scale, and rated as 10 compared with the zero point. Each of the grand divisions, consequently, represents ten per cent. of bark, and each of the smaller ones or subdivisions corresponds with one per cent. of bark. It is very easy, therefore, after having determined the length of the stem from zero, which sinks in a normal solution of bark, to apportion the rest of it with the aid of a pair of dividers; so that every interval thus apportioned shall be equal to that fixed by ex-

Fig. 118.



away, the greatest strength varies from thirty to forty-five degrees.

"After the leather has been thoroughly tanned and rinsed, or scrubbed by a brush machine or broom, it will tend very much to improve its color and pliability to stack it up in piles, and allow it to sweat until it becomes a little slippery from a kind of mucus that collects upon its surface. A little oil added to this stage of the process, or just before rolling, is found to be very useful.

"Great caution is necessary in the admission of air in drying when first hung up to dry. No more air than is sufficient to keep the sides from moulding, should be allowed. Too much air, or, in other words, if dried too rapidly in a current of air, will injure the color, giving a darker hue, and rendering the leather harsh and brittle. To insure that the thick parts, or butts, shall roll smooth and even with the rest of the piece, it is necessary that the leather should be partially dried before wetting down for rolling, and that, when wet down, it should lay long enough for every side to become equally damp throughout.

"The following table, condensed from the tanning records of 200,000 hides, exhibits the time required to tan the

periment. When, therefore, this instrument sinks into a bark liquor to twenty degrees, thirty, or any other degree, the number indicates the percentage of tanning force. It is necessary to observe that this instrument is applicable only to *freshly* made liquors; for otherwise, confusion and want of confidence might ensue upon finding that it sinks, sometimes, to a corresponding degree in spent liquor. This is owing to the fact that the alterations which tanning liquors undergo during use and exposure, may not diminish their density, though they impair or destroy their tanning power.

Baumé's hydrometer, which is frequently mentioned throughout this book, is similarly constructed, but with scales, differing in graduation with the kinds of liquid for which it is to be used. For full descriptions of these instruments, see *Encyclopedia of Chemistry*, p. 717, and MORFIT's *Applied Chemistry*, p. 296.

various descriptions of hides at my establishment, during a period of four years—it will be seen that the same descriptions of hides require different times in different years. This is owing mainly to the difference in the temperature and weather of the several seasons, and the quantity of sides and strength of liquor in the vats, and partly to the different conditions and qualities of the different lots of the same description of hides:

	No of sides.	Time of tanning. mo.	ds.
1841—San Juan	7,500	4	20
Orinoco	8,500	5	15
"	1,900	6	
"	9,000	6	10
Laguaira	22,000	7	15
Orinoco	6,500	5	15
Matamoras	1,100	5	
"	2,300	5	20
San Juan	6,500	4	15
Montevideo	5,800	4	
1842—Honduras	3,600	6	20
Buenos Ayres	10,500	6	10
Chagres	1,700	6	
1843—Orinoco	1,100	5	
Montevideo	2,700	5	
Rio Grande	5,800	4	20
1844—Buenos Ayres	6,500	6	20
Orinoco	5,400	7	
California	1,200	6	20
Buenos Ayres	900	7	10
"	6,500	5	10
1845—Orinoco	1,500	4	20
Rio Grande	2,100	5	
"	4,000	5	10
Orinoco	2,800	6	10
Laguaira	5,100	7	
Rio Grande	1,100	7	
Buffalo	2,000	5	
Buenos Ayres	2,000	6	
Rio Grande	8,500	6	10

"From the above table, it will be seen the average time of tanning in 1842, was five months and seventeen days; of 1843, five months and twenty-two days; of 1844, six months; and of 1845, six months and eleven days. Average of the whole time, five months and twenty-seven days. The average weight of the leather was over eighteen and one-half pounds per side. This, according to the best authorities we have at hand, is considerably below the time employed in England. There, it is no uncommon thing for eight and ten months to be employed in tanning a stock of leather, and some of the heaviest leather, it is said, takes even fourteen and eighteen months. Such deliberation undoubtedly insures a fine quality of leather, but it may be questioned whether there is not a great loss of weight—a loss of interest on capital, and in consequence an unnecessary enhancement of price, which does not suit the American market.

"In order to show the amount of business done, I have carefully collected and tabularized, from my books, the following statistics of the 'Prattsville Tannery' for twenty years, in tanning about 1,000,000 sides of sole leather:—

Statistics of the Prattsville Tannery for twenty years—various materials used and labor employed.

8,666 acres of bark land—10 square miles, 18 cords to the acre—120,000; at $3 per cord		$360,000
No. of days' work peeling and piling do.		118,555
4 trees to the cord		475,200
120,000 loads, or cords—264,000,000 lbs.		132,000
1,444 acres of wood land—32,000 loads, or cords, worth		32,000
35,380 bushels of oats, 2,6 per bushel		41,967
1,200 tons of hay at $8 per ton		9,600
313,000 days' work in tannery—1,000 years' labor at $14 per month	$162,000	
Board at $1,50 per week	78,000	
	———	240,000

500,000 hides, weighing 15,000,000 lbs.		1,750,000
Cartage, 5,700 loads of 2,600 lbs. each (one pair horses).		
1,000,000 sides sole leather, at 18 lbs. per side . .		18,000,000
Hides and leather, together		33,000,000
Cost of carting		52,800
3,000 lbs. per load of leather, one pair of horses	$6,000	
2,600 lbs. per load of hides, one pair of horses	5,700	
		11,700
Freight of hides and leather between New York and Catskill		30,000
Equal to 118,000,000 leather, at 7 cts. per pound . .		3,060,000
Lost and worn out about 100 horses, at $75 each . .		7,500
Cost of wagons, at $250 per year		5,000
Insurance on stock		12,000
Yearly expenses		800,000
Total expenses, about		6,000,000

"And, in justice to my workmen, I ought to say, without the use of ardent spirits, or ever having a side of leather stolen.

"A glance at this table will at once convince any one that the advantages of such an establishment are not confined to the amount of value produced. The labor employed directly or indirectly may be set down at two hundred men daily. The ramified branches of business and trade that it fosters; the comfort, refinement, and intelligence of which it becomes the centre; and its final influence upon the growth and populousness of the surrounding district, cannot, I think, be too highly estimated. The following table shows but one single item—the amount of labor employed within the walls, or that which is directly and immediately employed in the process of tanning; but, from a comparative inspection of it, and the table above, some idea may be formed of the amount of labor indirectly engaged.

Average number of men employed at the Prattsville Tannery throughout the year with their respective wages per month.

	No. of hands.	Pay per month.	
Beam-house.			
Foreman	1	$32	$32
Chorsemen	2	12 and board 6,	36
Beamsmen	12	14 "	180
In the Yard.			
Foreman	1	50	50
Handling and laying away . . .	8	12 and board 6,	144
Brushing leather	6	12 "	72
Nightman to leeches	1	14 "	18
Grinding bark by day	1	12 "	18
Grinding bark by night . . .	1	14 "	20
Wheeling bark	4	12 "	72
Filling and pitching leeches . .	3	24 "	60
Drying Loft.			
Foreman	1	20 "	26
Sponger	1	12 "	18
Rollers	2	15 "	42
Hanging up and taking down leather	2	12 "	36
Miscellaneous.			
Foreman out doors	1	41 "	47
Carpenter	1	39 "	45
Teamsters	12	11 "	218
Total	58		$1120
500 cords of bark at $3 per cord			1500
Cartage, repairs, &c. &c.			500
Grand total per month			$3120

"In the following table, I have given a condensed view of the operations at my tannery during five years:—

	No. of hides received at the tannery.	Weight of hides.	Cartage in New York.	Commissions.	Total value of hides.
1841	30,984	724,168	$291 47	$5701 47	$108,758 06
1842	27,194	601,595	275 89	3938 30	82,705 01
1643	28,438	630,192	213 24	4425 64	78,198 03
1844	36,839	812,408	276 28	5718 36	100,982 60
1845	20,556	460,798	154 17	2920 25	51,176 60
Total	144,006	3,229,155	$1211 05	$22,904 02	$421,810 52

Leather returned to New York.

	Sides.	Pounds.	Average weight per side.	Average net price.	Commissions.	Net proceeds.
1841	61,729	1,211,856½	29.63	14 44	$7352 24	$175,018 54
1842	54,323	995,057¾	18.32	13 93	5827 08	138,581 05
1843	56,742	1,061,523¾	18.71	13 69	6053 42	144,331 83
1844	73,590	1,310,779	17.81	12 55	6895 25	164,517 53
1845	40,891	737,789	18.03	11 16	3420 57	81,595 26
Total	287,275	5,316,789	18.51	$13 84	$29,548 66	$704,044 21

"The tanning of leather, more than almost any other manufacture, is a chemical process, the success of which depends almost wholly upon the skill and judgment with which its complicated manipulations are conducted. To attain the requisite skill in the laboratory of the chemist, is evidently impossible; it can only be acquired in the tanning itself, by long and careful attention and observation.

"The following tables present some facts which may be of general interest.

	1	2	3	4	5
1836	2151	48,130	22½	6594	7¾
1837	2305	53,172	23	5686	9
1838	3118	59,283	19	4991	10
1839	2984	59,675	20	6276	9
1840	3089	50,514	16⅓	6207	9¼
	13,647	270,774	20	29,752	9

	6	7	8	9
1836	397	3573	50,808	901,296
1837	500	4500	50,947	815,152
1838	496	4464	50,750	812,000
1839	558	5022	56,096	945,221
1840	590	5310	57,601	1,009,609
	2541	22,869	266,202	4,483,378

"NOTE.—Column 1, shows the number of days' work in the beam-house; 2, number of sides worked in; 3, average per man per day; 4, number of days' work grinding bark and tanning; 5, average per man per day; 6, number of leeches; 7, cords of bark used, at nine cords per leech; 8, sides of leather tanned; 9, pounds of leather tanned out.

"The labor in the loft and peeling bark during the above five years, was 8820 days. One man will work through the beam-house in one year 6260 sides. One man will tan and finish 2228 sides. One cord of bark tans 196 pounds.

"The question has been frequently asked me, how long does it take to tan sole leather? I answer, from four to six months, according to the strength of the liquor and number of sides in the vats; and the quicker tanned

the better. I would here remark, that several considerations must be noticed in order to meet the questions understandingly, and—

"1. I should say that the weight of the hides, every one knows, if heavy, requires more time than if comparatively light.

"2. If the hides are fresh, they are capable of being properly softened, and, if so, the process of tanning may be completed much sooner than in the case of old and hard hides, that cannot be softened with the same facility.

"3. If the hides have sufficient room in the vats, so as not to lay crowded, they will tan much faster.

"4. As the tanning advances, the liquor should be renewed seasonably, and its strength increased in a ratio proportionate to each stage of tanning.

"5. The question—is the leather to be tanned so as to barely pass in market, or to be well prepared, so as to make firm and solid leather? involves a consideration of much importance."

CHAPTER XXIV.

TANNING WITH MYRTLE, (VACCINIUM MYRTILUS.)

RAPÉNIUS, a tanner of Bern-Castel, upon the Moselle, has discovered that excellent leather can be made by tanning with the myrtle plant. This is collected with the greatest advantage in the spring of the year, because it can be dried and ground the most easily at that time. Three and a half parts by weight of this substance will tan perfectly one part of leather, while six parts of oak-bark are required for the same quantity. The use of this material, it is said, enables tanners to prepare leather in four months less than the usual time. The commission appointed at Trèves to examine the leather made by this process, reported that they had never seen a better product, and that each pair of shoes made with it would last two months longer than one made from common leather; also, that the skin from the neck, which is ordinarily so difficult to work up, became as strong and elastic as other parts when thus prepared. The myrtle should not be pulled up, but cut off, so that the roots may reproduce the following year. When cut, it is not injured by water, while oak-bark loses ten per cent. in value by exposure to moisture.

TANNING WITH GRAPE-SKINS.

Nachette, in a letter to the editors of the *Journal of Pharmacy*, August, 1829, announced that a chemist near Narbonne had proposed to substitute grape-stalks and skins for oak-bark in tanning.

To use his own words: "Many chemists have long sought for some economical substitute for oak-bark, but no one has before thought of employing for this purpose the stalks and skins of grapes.

"Struck with the inconvenience of the old method, in regard to time and expense of material, his attention was directed to this subject; and, having prepared skins for tanning by the ordinary processes, he placed them in vats filled with the stalks and skins of grapes—previously distilled, so as to save the small amount of alcohol remaining in them—and allowed them to remain thus surrounded for from thirty-five to forty-five days, which time he found amply sufficient. The advantages of preparing leather in this way are the following: 1. Much less time is required for the completion of the process. 2. A refuse material, abundant in some localities, is substituted for the expensive oak-bark. 3. A leather is procured which possesses an agreeable but only slightly-perceptible odor, instead of having the rank, unpleasant smell of that prepared with tan, which impregnates the persons and clothes of all those engaged in its manufacture. 4. Experience has proved that it is leather of the best possible quality, shoes made of it lasting twice as long as those prepared with ordinary leather."

TANNING WITH STATICE, OR MARSH ROSEMARY.

Tournel's experiments and process for tanning skins by means of statice-root, which we shall now give in detail, are extracted from a paper written by him on the subject.

"M. Gayraud and I commenced an experiment with an ox-hide, while Messrs. Malaret, tanners and curriers, of the same town, undertook to prepare some goat-skins.

"Gayraud followed the same course in preparing the hide as with the bark of the root of kermes-oak, except that he divided it into two exactly equal portions, and tanned one with statice and the other with the root of the kermes-oak, in order to determine what difference in weight would be produced by the different materials.

"Six months had elapsed, when the heat of the weather produced in the statice liquor so active a fermentation as to burst the containing vessel and spill the contents, thus making it impossible to carry out fully this first experiment. The tannin, however, had penetrated nearly to the centre, and the thinner parts were already perfectly tanned, and probably an additional exposure of only two months would have completed its conversion into leather. This leather was given to M. Camp, master shoemaker of the town, who asserted, after thorough examination, that it was of the very best quality. The Messrs. Malaret also declared their method of tanning the goat-skins to be superior to that with oak-bark.

"I then succeeded in tanning perfectly, in one year, a piece of a thick Buenos Ayres hide, which would have

required exposure for at least eighteen months in the ordinary way.

"These successful results led to experiments on a larger scale, and M. Gayraud commenced the tanning of more than a hundred horse-hides, and of fifty imported cow-hides; while Messrs. Malaret essayed with one hundred and fifty goat-skins, and M. Jacques Calas with eighty horse-hides; the cow-skins being intended for soles, and the horse-hides and goat-skins for upper leather.

"M. Gayraud placed the fifty cow-skins in the lime-pit, to separate the hair and *raise* them. As is commonly the case with imported hides, the liming revealed many defects and injuries which were before concealed, so that out of the fifty hides, at least one-third were more or less damaged, and some of them had to be trimmed to one-half their size in consequence of being injured. This circumstance prevented the correct estimation of differences in weight from the process, but the satisfaction was left to us of finding that the statice having fermented quickly and considerably, these hides were tanned in a third less than the usual time. Those which were originally sound, were remarkable for weight, beauty, color, and strength.

"M. Gayraud was so well satisfied with these results, that he purchased a number of perfect skins from the neighboring towns, and, after weighing them exactly, submitted them to the action of the statice in vats, and obtained with it a most satisfactory result.

"In the preparation of the horse-hides, the superiority of the statice over ordinary tan was evident in the finer structure of the product, the shortness of the process, economy of material, beauty of color, and increased weight, and power of absorbing fatty bodies. The same advantages were perceived and appreciated by Messrs. Malaret, in

the goat-leather tanned by them, and induced them to repeat the processes in other cases. The want of access to proper materials in Narbonne and its neighborhood, alone prevented me from extending these experiments to calf and sheep skins, and those intended for saddlers, harness-makers, and coach-makers, but I had already received sufficient evidence that this method would be equally well adapted for all kinds of leather, and was convinced that it rendered sole leather, particularly, firm and impenetrable, while it increased the pliability and strength of that intended for uppers. Its advantages, then, are economy of time and material, facility of preparation, softness and impermeability to water, beauty of color, and durability.

"All the skins thus prepared have been sold, and the workmen who have used them have unanimously given them the preference over those made in the usual manner. They are believed to equal skins tanned with kermes-oak bark for wear in damp weather, while in dry weather they are much superior as to flexibility; and, moreover, they hold thread better, and are more easily worked. The leather for uppers is remarkable both for suppleness and firmness, and for the brilliancy, intensity, and durability of the black color which can be given to it."

MODE OF PREPARING SKINS BY MEANS OF TAR AND SOOT.

Barry's Process.—The tan liquor for this preparation is made by mixing twenty or twenty-two pounds of good tar with 105 gallons of boiling water, and adding enough lime to form a thick paste. A quantity of cold water, sufficient to slack the lime, a bucket-full of lime, and the same quantity of tar are then added, and the

whole is thoroughly stirred to the consistence of a thick paste. This mixture is distributed in a number of vessels, or vats, and is thinned with boiling water. The vessels are covered, and in twenty-four hours their contents are ready for use.

The soot-liquor is prepared by mixing together 110 pounds of soot, 4½ pounds of powdered lime, and 485 pounds of water, the whole being stirred up during the gradual addition of the water. The vessel is covered, and the liquor filtered at the end of twenty-four hours.

Skins which are intended for polished leather, are first prepared for tanning by the ordinary processes, and are then placed in cold vats of gallic acid and decoction of bark, in which they are allowed to remain four or five days or a week, being taken out and handled three or four times a day. They are then deposited in the warm tar-liquor, having, at first, only one-half the strength above stated, but which is gradually increased to the original degree of saturation. After fifteen days, the skins are replaced in the vats and treated as before; and then deposited in weak tar-liquor, being taken out and replaced three or four times a day for the first fifteen days. They are then deposited in liquor of the full strength and worked as before, until they are well penetrated by it, and are finally kept for a week or more in a vat of hot decoction of coppice oak or sumach, and then dried.

Skins for sole leather are prepared in the usual manner, and are then soaked for some days in a cold vat of gallic acid and decoction of bark, being treated as is directed for polished leather. They are then immersed in a warm, weak soot-liquor, of about one-third or one-half the strength above indicated. After having been alternately taken out and handled in this liquor three

or four times a day, they are then deposited in a vat containing hot soot-liquor of the original strength, and are worked in it three or four times daily, as above directed, until completely saturated. They are then taken out and dried, soaked in hot water for half an hour, cleaned and brushed upon the marble slab three or four times on both sides. Finally, the skins thus prepared are immersed four several times daily in a strong hot ooze, until the tanning is completed; care being observed to dry them after each immersion.

TANNING WITH FURZE.

According to Rankin, the furze or heath which is so common in Ireland, contains a tanning principle, and may be used as a substitute for oak-bark. Having succeeded in a number of trials, he published the following process. The furze is boiled with water, for three hours, in a large boiler made of any material except iron, which is suitable for the purpose, and the liquid is decanted into large vats, so placed that it can be drawn off when desired. The skins are then deposited in this liquid as soon as its temperature has fallen to about 95° F. The liquor must be frequently changed, the same precautions being taken each time. Complete success was attained by this method, which "feeds" the skins more rapidly than the cold processes.

CHAPTER XXV.

ENGLISH HARNESS LEATHER.

THE fine brown leather made in England for saddlers' use is very highly esteemed, and, notwithstanding its costliness, is much sought after, being superior to any other in suppleness, density, and color. Its excellence is not attributable to any novelty in the processes employed in its manufacture, or to the use of complicated and costly machinery, but solely to the care with which the materials are selected, and to the skilful and accurate manipulation of the workmen.

The finest skins used for this leather come from cattle raised in Wiltshire and Somersetshire, the climate and pasturage of which counties seem to be best adapted to secure the development of tissue in these animals, and particularly of the firm, elastic, and resisting integuments which are so necessary for the production of grain leather.

The preference is given to the skins of cows or of young bulls, which are usually tanned in the neighborhood of Bristol, and then sent to London, where the finest of them are selected by the manufacturers.

According to Jähkel, the processes of tanning to which they are subjected are in general similar to those elsewhere employed, and comprehend, besides liming and the separation of the hair, the use of *grainers* of chicken's

weak bath of sulphuric acid; being quickly taken out after each immersion, and immediately afterwards well rinsed in pure water, to dissolve out the acid, which, if allowed to remain, might act injuriously.

The leather is then, after being dried, oiled upon the flesh with pure cod-liver oil, and, when thoroughly penetrated by this, with a mixture of the best quality of whale-oil with half its weight of tallow; being in the mean time scraped as usual upon the grain with the fleshing-knife. It is then pared, slicked, and beaten out flat; all these operations being conducted by hand, and not, as some suppose, by machinery; the excellence of the product depending entirely upon the skill and attention bestowed upon it by the workman.

BUTTS, CALLED RED LEATHER.

Butts from Buenos Ayres, or from the Colonies, are almost exclusively used for the manufacture of this kind of leather. They are first soaked for four or five days, and then deposited in an old lime-vat, and evenly extended, so that they may not wrinkle; the hides of the very largest size being cut in half along the line from head to tail. After repeated handling in this pit for five days, they are taken out, freed from hair, and deposited in a fresh vat, in which they are allowed to remain two or three months. During this process, they must be handled twice a week, and a little fresh lime should be thrown in during each of the last five handlings. When ready to be fleshed, they are taken out and rinsed four times, only partially, so that the lime, which is the cause of their rigidity, may not be entirely washed out.

Being thus prepared, the hides are placed in the pit and stratified, not, as in the manufacture of common

or pigeons' dung, dipping, immersion in tan-baths of different strengths, and two separate tannings in pits, with fresh bark of the finest quality. The currying which the leather undergoes in order to adapt it for the purposes of the saddler, serves to remove its original dryness, stiffness, and depth of color, and to render it supple, elastic, and impervious to moisture, without diminishing the solidity and density of structure given to it by the tanning.

The leather is first cut in half along the length of the skin, and is then repeatedly soaked, beaten, and washed in pure water, in order to dissolve and remove the gallic acid and extractive matter, which, if allowed to remain, might, by further oxidation, deepen the color, and interfere with the proper absorption of the substances which are afterwards applied. All foreign bodies having been removed by these means, the skins, although saturated with the tannin of oak-bark, are yet in a condition which enables them to absorb sumach; and they are accordingly deposited in a bath containing one-quarter of their weight of powdered sumach. The leather is taken out and dipped again in a new position, two or three times every day while in this bath, the powder which has settled to the bottom being stirred about each time; and at the end of the second day, a quantity of sumach, equal to that originally deposited, is added. The skins are taken out at the end of three days, which time is usually sufficient for their saturation, and are then found to be not only improved in color, but to be much more soft and pliable than before the treatment.

In order still more completely to develop the peculiar bistre-like yellow tint of these skins, which constitutes their beauty, they are washed in water to remove excess of sumach, &c., and then passed repeatedly through a very

weak bath of sulphuric acid; being quickly taken out after each immersion, and immediately afterwards well rinsed in pure water, to dissolve out the acid, which, if allowed to remain, might act injuriously.

The leather is then, after being dried, oiled upon the flesh with pure cod-liver oil, and, when thoroughly penetrated by this, with a mixture of the best quality of whale-oil with half its weight of tallow; being in the mean time scraped as usual upon the grain with the fleshing-knife. It is then pared, slicked, and beaten out flat; all these operations being conducted by hand, and not, as some suppose, by machinery; the excellence of the product depending entirely upon the skill and attention bestowed upon it by the workman.

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Being thus prepared, the hides are placed in the pit and stratified, not, as in the manufacture of common

leather, with the bark of oak branches, but with the bark of the root of the evergreen, or scarlet oak, which has been soaked in water. After being left for three months in the first pit, they are placed in a second one, in which they are exposed to the action of the bark for the same length of time, and then are taken out, dried, and delivered to the currier. About 120 lbs. of this kind of bark are required for each hide.

CHAPTER XXVI.

CALF-SKINS.

THE tanning of calf-skins is conducted much in the same way as that of small cow-hides. After having been pressed, to expel oleaginous matters, they are passed three times through old, and once through fresh lime-vats; but being too weak to bear the full strength of the lime, this should be done after the passage of cow-skins through the vats has somewhat diminished its activity. If they are dry when they enter the tannery, they should be first trodden out and soaked. They are then freed from their lime by the scraper, carefully fleshed, and rinsed, after which they are ready for a part of the process, which differs from that used for cow-skins.

This consists in placing from fifteen to eighteen skins in a tub, and beating them for eight or ten minutes. This operation, which softens the fibre, should be repeated after each rinsing, though it is omitted in the establishments where the skins are rinsed as often as six times. The beaters are wedge-shaped, and from 8½ to 10 inches in height.

After the skins are *entirely* free from hair and lime, they are placed in the hot ooze and water, and treated like cow-skins, excepting that they require more frequent and careful handling. Care should also be taken to put fresh tan each time into the vats. They are then sub-

jected to the action of stronger ooze and tan, in the same manner as other skins, for a month, and are afterwards transferred to the pits. In these, unlike crop-leather and hides, they are folded lengthwise and unequally, and thus spread over with tan, care being taken to cover the heads and tails, as being the thickest portions, with rather more tan than the other parts. The tan used for calf-skins should be of the very finest quality. Exposure in the first pit continues about three months. They are then taken out, freed from all particles of tan which adhere to them, and placed in the second pit with tan, which is also in the finest state of division. They must be folded double and unevenly as before, but in such a manner that the part before covered shall now be exposed. The pits are then filled up as usual, the whole moistened with warm water, and left for three months, when the skins may be considered as ready to be placed in the hands of the currier.

Some manufacturers, in tanning calf and sheep skins, use a warm infusion of bark to moisten their pits with, instead of cold water. This is probably an improvement upon the old process.

As it isall-important to have the skins soft and in a condition to absorb the tanning liquor readily, some tanners accomplish this end by removing all traces of opposing substances, such as lime, grease, and glutinous matter, with the aid of an alkaline lye. This alkaline lye consists of water impregnated with pigeon's or hen's dung, and is technically termed a *grainer*, or *bate*. Ten or twelve gallons of dung suffice for one hundred skins; and during the time they remain in the bate-liquor, which is generally from eight to ten days, they must be frequently handled and scraped on the beam. After the

action of the bate, the skins assume the form of *pelts*, in which state they are placed in the ooze-vats.

The bate acts by means of the muriate of ammonia, which it contains. The lime in the skins decomposes this muriate of ammonia, takes its acid, and becomes muriate of lime, which is soluble, and is carried away by the wash waters, while the ammonia passes off in a gaseous state. If the bate consists of fresh *dung*, the organic matter contained in it is liable to putrefactive fermentation, which involves a partial decomposition of the gelatinous tissue, and consequent loss, and at the same time imparts a very undesirable color to the leather.

Kampffmeyer gives the following results of a series of experiments, made by him to determine the comparative availability of oak-bark, catechu, divi-divi, and alder, as tanning material for calf-skins.

Twenty-five calf-skins, as much alike as possible in appearance, quality, and state of dryness, were selected, and seven of the number were tanned with oak-bark, six with alder-bark, six with catechu, and six with divi-divi. All of these skins were made to undergo the preparatory processes during the same length of time, and exactly in the same manner, except that a certain number were limed in the ordinary way, and the rest were exposed to sulphuretted lime from the gas-works. After being freed from lime, they were simultaneously deposited in the different pits. The following were the results of the tanning:—

Oak-bark.—The three skins which had been depilated by "gas-works lime," weighed originally 14 pounds 2 ounces. After being tanned and tallowed, they weighed 13 pounds 9 ounces, showing a loss of 19 ounces. The quantity of oak-bark used was 95 pounds.

The four skins treated with quicklime weighed originally 16 pounds 3 ounces, and lost 15 ounces by the tanning. These skins, which had exhausted 118 pounds 12 ounces of tan, were found to be very well tanned and of a finer grain than any of the others. Those prepared with "gas-works lime" were firmer, without having suffered any diminution of their softness and pliability, and working with the flesh-knife brought out a fine surface.

Divi-divi.—Of the skins tanned with this material, the three which had been treated with "gas-works lime" weighed originally 12 pounds 2 ounces, and were found to have lost after tanning 6 ounces; 14 pounds 7 ounces of divi-divi having been used.

The others, which were freed from hair by means of quicklime, weighed at first 11 pounds 9 ounces, and lost 10 ounces. The same proportionate amount of divi-divi was used as for the others.

The color and appearance of the leather were, in every instance, most satisfactory. The grain did not look quite as well as that of the leather tanned with oak-bark, but was sufficiently fine.

Catechu, or *Terra Japonica.*—The three skins treated with "gas-works lime" weighed at first 10 pounds 13 ounces, and gained 10½ ounces during the tanning; 14 pounds 7 ounces of catechu having been consumed.

Those prepared with quicklime weighed originally 13 pounds 2 ounces, and gained 6 ounces by being tanned. The same quantity of catechu was exhausted as before. These skins were nearly perfectly tanned. Their color was of an orange hue. The flesh sides were uneven and rough, the texture loose and spongy, and the grain much inferior to that of those treated with the other materials.

Alder-bark.—The three skins prepared with "gas-works

lime" weighed 12 pounds 2 ounces, and gained 5 ounces in the tanning, 171 pounds of alder-bark being used. The three which were limed in the ordinary manner weighed at first 11 pounds 1 ounce, and lost 7 ounces in the tanning, and 134 pounds of the bark were used for these skins.

Notwithstanding the very large quantity of bark employed, all of the skins were imperfectly tanned, particularly those which were treated with lime from the gas-works. They were so hard and dense as to be impervious to grease. The grain was bad, and brought out with difficulty, and their stiffness and dryness were so great that the hair side cracked when the leather was bent. They were of a deep brown color, inelastic, and inferior in every respect to all the others.

In comparing the two modes of unhairing skins, the author believes that the use of "gas-lime" offers some advantages over the old method of depilating by quicklime. There is little difference between their cost, and the skins treated with the former are perhaps finer, more pliable and durable, and more impervious to moisture.

The results of the experiments prove that the use of catechu for tanning in the dry way is almost inadmissible, giving rise as it does to a porous and loose condition of the texture of leather. The experiments with alder-bark were still less satisfactory. The skins tanned with oak-bark and divi-divi were, on the whole, equally good; while there is not much difference between the actual expense of these materials, since the latter, though much more costly, contains nearly six times as much tannin as the former. One objection to its use arises from the difficulty of reducing it to powder between the ordinary grindstones, owing to its coriaceous and glutinous nature.

Very nearly the same results as those above described

were obtained by the tanning of raw Buenos Ayres hides, the divi-divi preserving its character for superiority to the catechu and alder, and being equal in most respects to oak-bark. There is more care to be observed in its use, though it effects the tanning in one-third less time than oak-bark. The best mode of employing it is in the form of an extract, and in combination with oak-bark, as is done in England; the skins being covered first with a layer of divi-divi, and then with a thin stratum of tan.

According to the author, the divi-divi is the only substance that can successfully or profitably replace oak-bark, and a reduction in the price of the article will probably give rise to a very general employment of it.

CALF-SKINS, IMPROPERLY CALLED "ALUMED SKINS."

Alumed calf-skins are very little used, and are chiefly employed by bookbinders. The secret of their manufacture was for a long time unknown; but the following account was given by reliable persons to Delalande, from whose work it is extracted.

The dried skins of stillborn calves, or others of low price, are selected for the manufacture of this so-called alumed leather; those which have been injured by weevils or worms being rejected. In opening them, they are strongly beaten with a stick to get rid of dust and insects, and are then deposited in a place which must not be either too damp or warm.

Thirteen dozen dry skins are worked at a time. They are deposited in an oval pit, dug out in the ground, which is from 11 to 13 feet long, by 3½ to 4½ feet wide, and 6½ feet deep. The water is passed into this pit through an oval aperture, a foot and a half in height, and narrow

enough to prevent the skins from escaping from it, and drains away through another similar opening.

The water used at Verneuil, where this kind of leather was originally prepared, is supposed to possess peculiar virtues, especially fitting it for the preparation of these skins; and, for a long time, the erroneous opinion was entertained that they could only be properly prepared by its use. Hence the precautions adopted to secure the exposure of the skins to a constant stream of it.

The skins remain in the pit two or three days in summer, and six or eight in winter. When taken out, they are stacked, and the next day are scraped upon the horse with a blunt knife. They are again deposited in the vat, and left during two days, after which they are scraped as before, and, if not sufficiently softened, are exposed a third time in the pit for a day and again scraped. They are then placed in the lime-pit, which is a hole from 4½ to 5 feet in depth, and of proportionate length and breadth. From 40 to 50 buckets of water are thrown into this with a cask-full of lime, which is left to slack for 12 or 15 hours. After this, the contents of the pit are thoroughly stirred by means of a long pole, while the skins are deposited singly and dipped with a stick. After remaining in the lime-pit for a day, they are taken out, spread, and stacked, and subsequently passed, in the same way, through new lime-pits, gradually increasing in strength, until the hair is ready to be removed. They are then well washed in running water, deprived of hair, and deposited again in a vat similar to that first described, and allowed to soak over night, being kept in position by a long heavy pole placed longitudinally above them. These operations concluded, they are well fleshed to the quick with a sharp knife, upon the horse, until the flesh

side can scarcely be distinguished from the grain. The heads and necks are thinned down until they become of equal thickness with the other parts of the skins, and the ears, tails, and other extremities are cut off, and preserved for the manufacture of glue. After being exposed to the air for a day, and kept in the pit over night, they are again fleshed, but with a duller knife than that first used. They are next returned to the first pit, and left over night in the water, and the hair side is worked upon the horse so as to expel the last portions of lime. The next process is to empty three or four buckets-full of dog's-dung or chicken's-dung into a large vat, and to mix it thoroughly with a bucket-full of water, which is done by the workman entering the vat and stamping upon the contents with his feet. Cold water is then thrown in until the vat is half full, and hot water from a large boiler is mixed with it. After this, the skins are thrown in, and are stirred about in the vat for some minutes with large sticks, when the greater part of the liquor is drawn off into a boiler to be heated, and the skins, after having been left for an hour, are arranged in a corner of the vat, and kept in place by two sticks crossed over each other. The hot liquor is then poured into the empty part of the vat, a bucket-full at a time, being well stirred all the time, and mixed with the cold liquor, so as to avoid injuring the skins by scalding. When the water is sufficiently hot, the sticks are removed, and the skins are forcibly stirred around in the vat three or four times. The liquor is then returned to the boiler, and the same process is repeated, great care being taken not to add the hot water too rapidly to the contents of the vat, and to try its temperature frequently with the hand. The skins are left in for half an hour.

The workman then collects them together in a corner

of the vat, and examines them carefully, stretching them in every direction, and when he finds them perfectly pliable and soft, they are ready to be taken out. He removes, at first, one or two dozen of those which are the most advanced in preparation, and deposits them in buckets, after which he empties the vat of water as before, and turns the skins three or four times. After a quarter of an hour, the boiler is again filled, he collects the skins together and takes out more of them, and so on until they are all removed from the vat.

The greatest care is necessary on the part of the workman during these operations; for, if the skins are allowed to remain in the hot mixture after they have reached the proper point, they will be rapidly softened and destroyed; while others, at the end of the same time, may not have been exposed long enough for their complete preparation. A repetition of the processes described, continued for six or seven hours, is sometimes necessary for imparting the requisite qualities to the stronger skins. Experience and frequent examinations of the skins alone can enable the workman to determine the proper time for removing them from the vat.

When this part of the process is finished, the skins, as they are taken from the vat, are stretched and scraped upon the beam, in order to soften, distend, and clean them; and if any are found to be still too firm, they are replaced in the vat while the rest are being washed. The contents of the vat are then allowed to escape through the bunghole, and it is well washed out and half filled with clean river-water, while a basket-full of fresh tan is thrown in. The skins are then washed and stirred about in this water with sticks, and handled by the workmen, and left in the vat until the next day, when they are taken out, drained upon the planks, and

transferred to the care of the sempstress. Each skin is carefully examined by her, any holes which may exist being closed; the skins, excepting the tail part, are then sewed with the flesh side outwards, into the form of a bottle. For this purpose, she uses a large needle, which is flat at the point, and, with a double thick thread, stitches one part of the skin at a distance of one-fifth of an inch from the edge, and the other that of half an inch, turning over the latter upon the former in a hem, but not pressing it down tightly enough to prevent water from draining through, or to cause the production of dark spots and lines after tanning. A workman then places in each bag of skin a quantity of tan, proportioned to its size, after which, the sempstress sews up the tail part close by the hind legs, so as just to permit the introduction of a copper socket for a wooden funnel. The bags are then brought near to a vat in which the tanning has just been completed. The sacks in this vat are removed to a rack, in order to be unripped. The vat is left half full of the old liquor, and there is then poured into it a quantity of hot fresh liquor sufficient to make the contents lukewarm. This fresh liquor is prepared by pouring the contents of the already tanned sacks into a vat provided with an upright door or partition at one end, through which the liquor, which has drained from the tan, passes, and collecting, in the empty space, is transferred to a boiler. The workman then takes a bag of skin, and empties into it, through the funnel, a small bucket-full of water, and closes the mouth by tying it up with a small strip or thong, which had been previously cut from the skin for the purpose, and left hanging from the tail. The bags, having each been filled with the same quantity of water, are then placed in the vat and left for an hour, while another portion of liquor, prepared

by percolating through tan, as above described, is being heated in the boiler. The workman, then placing the bags upon a rack at one end of the vat into which the heated water has been poured, fills them again through the funnel from his little bucket, tying them as before, by which they are made to assume a pyramidal shape in the vats. This operation is repeated a third time at the expiration of an hour, the heat of the liquor being increased as before. The liquor should be less heated for those skins which have been a long time in the lime-pits, than for those which have been a shorter time; but the skill exhibited in making this distinction can only be acquired by long experience.

The next day a similar operation is performed in a third vat, while the bags deposited the day before are left to soak in the vat. The third day the skins of the first vat are taken out and left to drain upon a rack placed over the vat. They are then thrown upon the rack in the vat, upon which they are unripped and emptied of their tan. They are then folded with the flesh side within, and well washed in running water; they are placed upon a trestle to drain; are opened at the hind quarters, and hung up in a shed, with their heads down, on nails placed some distance apart.

When dry, they are piled up and left until ready to be sent to market. They are then moistened, if in summer, by exposure to the dew of night air; are trod out by workmen with heavy shoes, in order to render them supple, and to efface the marks of the sewing; and are assorted, according to size, into packs of six each, which are tied together by the heads with pack-thread.

The greatest care is required in all these processes not to allow the skins to remain too long in the dung mix-

tures, or to permit the water employed to be too hot, since either of these circumstances will make them so soft as to be easily torn. Those prepared with chicken-dung are so thin as to be almost transparent. Manufacturers have the idea that lightning and fogs injure these skins, or interfere with their preparation, and usually carry on their manufacture, as much as possible, in spring and autumn. The hog-skins used by bookbinders for Bibles and church-books are prepared in the same manner as the calf-skins, but they differ from them in being exceedingly thick and strong.

The tanned sheep-skins, used by bookbinders, are not alumed like the calf-skins, but are only limed and tanned. Some of these are sewed up and tanned similarly to the calf-skins, while others are tanned by stratifying them with bark.

CHAPTER XXVII.

TANNING OF GOAT AND SHEEP SKINS.

GOAT and sheep skins are converted by the tanners into *true Morocco, imitation Morocco, skiver, and roan.*

True Morocco.—Owing to the comparative scarcity of goats, the tanners use very few fresh skins, their supplies being drawn from Switzerland, Germany, Africa, East Indies, and Asia Minor. As imported, they are dry, and covered with hair, and require breaking and softening, which is done by soaking them for several days in water, treading them under feet, rinsing and scraping them on the flesh side to produce evenness. They are then made to pass through three old lime-pits, and after the hair is removed, through a fresh pit, the same precautions being observed, throughout, as in the treatment of calf-skins. This process is continued until the hair can be easily detached, which generally requires about a month, and the skins are then scraped on the beam, re-immersed in lime-milk for two days, and again fleshed with the scraping-knife.

Goat-skins being of a dry nature, require more rinsing than others, and the operation must be frequently repeated many times in running water.

The unhaired skins are then "bated" with pigeon's, chicken's, or dog's dung, to remove excess of lime. Fermented bran-water is sometimes used as the bate.

After being again scraped, the skins are sewed into bag form with the grain side outwards, and partly filled through a funnel with a strong decoction of sumach; they are inflated by the breath, tightly closed, and thrown into a vat (Fig. 114) containing a shallow depth of weak

Fig. 114.

liquor of sumach, and therein made to float about by means of constant agitation, so as to insure the uniform action of the tan-liquor throughout the surface of the skin. After a few hours, the bags are taken out, and piled upon each other so as to promote by pressure a thorough penetration of the liquor through the pores of the skin, and consequent chemical combination. This process is repeated with new liquor, and the bags are then unstitched, rinsed, and scraped on the beam, and suspended in the drying-loft. These "crust" skins, as they are termed when in this latter condition, are moistened, rubbed out smooth with a copper tool upon a sloping board, and hung up to dry, previous to undergoing the process of coloring. This method tans the goat-skins in one day.

Another plan is to steep the skins for several days in a fermenting mixture of bran-water, scrape them on the beam, and soak and rinse them in clean water. After

being limed in the usual manner, they are worked or rubbed over with a tool of hard schist, to press out the lime, smooth down unevenness, and soften the grain, and are then fulled by agitation in a revolving cask, lined within with pegs, and containing water.

The tanning is then effected in the manner before mentioned, two pounds of Sicilian sumach being required for each skin. In France, the tanning is accomplished very much in the same manner as by the fulling above described; the skins and tan-liquor being placed together in a churn-like cask, and the chemical combination promoted by causing it to revolve upon a horizontal axis.

Imitation Morocco.—This leather is prepared from *sheep-skins*, in the same manner as true Morocco; except that, after being stripped of wool, they must be subjected to powerful hydrostatic pressure for the expulsion of oleaginous matter, which, being contained in large amount, would otherwise seriously interfere with the tanning.

They are limed in pits containing 33 pounds of lime for every dozen skins, and are allowed to remain from three weeks to a month. They are then deprived of hair, are resteeped in the pits for five or six days, rinsed, beaten in tubs, and, when perfectly clean, deposited in ooze for a month.

When sheep-skins are tanned for common leather, oak-bark is used instead of sumach.

Morocco is classified in commerce under the head of fancy leathers, because it always reaches market with a highly finished and colored surface on the grain side.

The color is imparted in the same manner as cloth is dyed—by means of the chemical combination of a pigment with a mordant.

Some tanners dye the skins when they reach the state preparatory to going into the tan-liquor, by sewing them

together edgewise, with the grain outwards, then mordanting, and afterwards giving them two immersions, of a half hour each, in the dye-bath.

The most common method, however, is to take the tanned skins as they come from the drying-loft, place two together, and then rub them over exteriorly with a brush containing the mordant solution, and afterwards to apply the dye liquor in the same manner. When the dyeing is finished, they are to be rinsed, drained, spread out, sponged with oil to preserve their flexibility, and then sent to the curriers' shop to be finished.

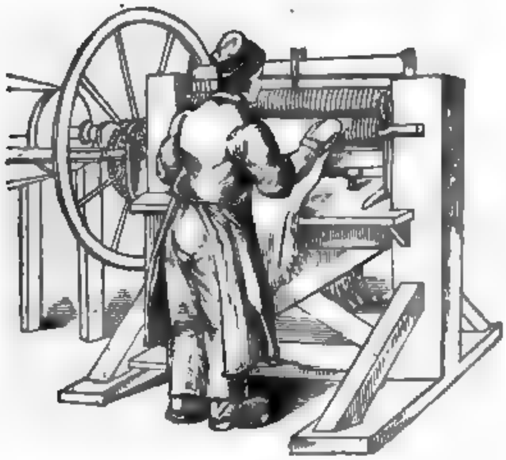
Black.—This color is imparted by the application of a solution of red acetate of iron; *crimson*, by a mordant of alum or tin salt, and decoction of cochineal; *puce*, by mordant of alum and decoction of logwood; *blue*, by a solution of sulphate of Indigo; *olive*, by a weak solution of copperas, as mordant, and decoction of barberry containing a little of the blue bath, as coloring liquor; *violet*, by the consecutive application of decoction of cochineal and weak Indigo bath.

Skiver.—This kind of leather is made from sheepskins split in two, while in the state of pelt, by machinery. It is tanned by sumach in vats, being spread out, instead of sewn into bag form, as from its lesser thickness it is more readily impregnated with the tan material.

The extreme thinness of a sheep-skin renders necessary a peculiar apparatus and nice manipulation for its bisection. The splitting machine used at the Bevingtons, is shown in Fig. 115, which also represents a skin undergoing the process of being split. A double advantage is derived from this manipulation, one skin being made into two portions, which are then respectively adapted to uses for which the original skin, on account of its thickness, was not suited. The vibrating knife,

and rollers, may be so arranged as to give an equal thickness to both sections of the skin, or a greater thickness to one side than to the other, as may be desired. The knife cuts slowly, but completes the section in about two minutes.

Fig. 115.



This kind of leather is used for hat-linings, pocket-books, box-covers, and like purposes.

Roan is sheep-skin Morocco tanned with sumach, but wanting the grained appearance of true Morocco, which is imparted by the grooved roller in the finishing.

CHAPTER XXVIII.

TANNING OF HORSE-HIDES.

PREVIOUS to 1790, the manufacture of good leather from horse-hides was considered so problematical, that the duty upon them, in France, did not exceed the half of that levelled upon neat hides. They were seldom seen in tanneries, and it was impossible to pass them off upon shoemakers, as the long necks, the unevenness of the mane portions, and deep creases, made their character manifest. At the present day, however, they are largely converted into leather; and experience has proved, that they make excellent material for uppers, and the legs of boots.

Horse-hides are limed in precisely the same way as calf-skins, but, on account of their greater thickness, they require a longer exposure in the tan-pits, eight months being usually necessary for this purpose.

According to Dumas, "horse-hides are tanned with great ease, and excellent leather can be made from them in fifty days, if prepared in the following manner, which is that adopted by Reulos and Budin, tanners who have devoted their attention to this branch of the business. The skins are soaked for a night, and then passed successively through three lime-pits, remaining one day in each, the fresh pit being charged in the proportion of 20 bushels of lime for 140 skins. Having been taken out

and thoroughly washed in running water, they are worked in the usual way upon the beam, and then passed through the vats, remaining six, eight, and in winter, ten days in the first one. During this part of the proceeding, they are taken out and replaced from time to time; as often as eight or ten times daily, for the first few days. The liquid of the first vat should indicate a density of °0.7, by Baumé's areometer. That of the second vat should be at °0.9, and while in this, the skins should be taken out only once a day. After nine or ten days, they are removed to the third liquid, which has a density of °1.2, and are allowed to remain in it about the same length of time, and are finally kept for twelve or fourteen days in the last vat, at 2° Baumé. During this last period, two baskets of fresh tan, weighing 55 pounds, should be daily thrown into each vat.

"After removal from the last vat, the skins are thoroughly tanned. They are then rubbed upon marble tables, first on the flesh, then on the hair sides, half-dried upon hooks attached to the ceiling of the drying-room, and sent to the currier in a slightly moist state.

"A horse-hide weighing 22 pounds loses 6½ pounds in undergoing cleaning, but gains 8½ pounds in the tanning. This method of tanning is very simple, although requiring all the attention and care of the workmen, and differs from that of other skins, at least in the establishment referred to, in their not being placed at all in pits, and in being subjected to the action of tannin while floating in liquid."

CHAPTER XXIX.

BUCK, WOLF, DOG, AND OTHER SKINS.

The skins of the buck, the wolf, the elk, the dog, and other animals, are equally susceptible of tanning as those of the goat and sheep. Those of the lamb, the kid, the cat, the rabbit, and hare do not require exposure to as strong infusions, nor for so great a length of time, as sheep-skins, while those of the hog, the wild boar, and bear are prepared exactly like them. When these skins are fresh, and when it is intended to preserve the hair or fur, the time may be considerably abridged.

HUMAN SKINS.

Human skins can be tanned like others. They have more body than cow-skins, and, unlike them, are thickest upon the abdomen. Those who have experimented upon this most disagreeable subject, assert that they require a greater number of limings and of exposures to the infusions of bark, and that they swell up a great deal under these operations. A tanned human skin is exhibited in the Museum of Natural History at Versailles. The skin of General Morland was exhibited some time since in the Museum of the Faculty of Medicine of Paris, and we have seen a wig exhibited by the brothers Normandin, hairdressers, which consisted of a tanned human scalp with the hair left on.

CHAPTER XXX.

BUFFALO, OR "GRECIAN LEATHER."

This leather is made of buffalo-skins, and differs from other kinds in being tanned with myrtle-leaves instead of oak-bark.

These skins, which are always brought to the tanner in a dry state, are soaked in water for five or six days in order to soften them, and are then deposited in an old lime-pit, and there allowed to remain until the hair comes off with ease, which usually happens at the end of eight or ten days. During the liming, they should be taken out occasionally, stacked for short intervals, and replaced in the vats. When the hair is just ready to come off without difficulty, they are scraped upon the beam.

They are next soaked in water for two days; then worked upon the beam with a fleshing-knife, and rinsed three or four times, which should be sufficient to make them supple and to remove all the lime.

The skins are then ready to receive the first coloring. For this purpose, they are placed upon each other in large vats, are covered over with myrtle-leaves, and, to complete their preparation, the vats are then filled with a boiling decoction of powdered myrtle-leaves.

After the skins have been moved about in this liquid, which should always be in sufficient quantity to cover them perfectly, they are taken out and sewed up as other

skins are in processes already referred to. They are then filled up with the leaves and fluid in which they had been immersed, and again replaced in the vat, which is supplied with a similar but fresh mixture. This mixture must be renewed every day if it is desired to impart a fine color to the skins. To complete the process, it must be continued for ten or twenty days, the skins being frequently stirred and moved about in the liquid. Some tanners, however, only stir them about two or three times daily, and once a day throw into the vat a boiler-full of hot myrtle decoction.

The skins, being ready for the vats, are ripped up and torn through from tail to head. The bottom of the pit being bedded with powder, the skins are placed upon it with the hair side up, and are then covered with a moistened layer of myrtle leaves, over which skins are placed as before, and so on until the pit is full. The skins are left in this state for three months, and, all the precautions usual in common tanning having been taken, are then removed, well cleaned in water, and again stratified in the same way with myrtle-leaves for three months longer. This process is repeated four times more in the same manner, until, at the expiration of a year and a half, they are taken out and dried like other skins. Some tanners keep these skins in the pits for at least three years, but this length of exposure is not regarded as at all necessary.

When nearly dry, the weak parts of the bellies are cut out, and all the wrinkles in the skins are flattened by means of a mallet or a smoothing-iron. They are then entirely dried by exposure to the open air, and greased upon both sides. In order that the fatty matter may penetrate them perfectly, they are *flamed* by being passed over a charcoal fire in every direction, until

thoroughly warmed throughout; and, when it is evident that they will absorb no more, are once more warmed and then piled up and covered with planks, which are pressed down with large stones or heavy weights.

The next day, they are taken down and dried thoroughly by exposure to the open air, when they will be found to have acquired the necessary whiteness and firmness.

CHAPTER XXXI.

RUSSIA LEATHER.

The Russians have long been in possession of a method of making a variety of fancy red-colored leather, called by them *jucten*. This article has a peculiarly agreeable and characteristic odor, is not subject to mould when exposed in damp situations, and is proof against the attacks of insects, even expelling them from the vicinity of its odor.

A description of this process has been published by Pallas and by Fischerstroem, and a manufactory of Russia leather was established at St. Germain, more than sixty years ago, under the auspices of M. Teybert; but it did not prove as successful as was expected. Since then, the manufacture has been more generally introduced into France. The following account of the process is chiefly taken from the prize work on the subject by Grouvelle and Duval-Duval, and from the *Technological Dictionary* of M. Payen; but all the published descriptions are more or less imperfect, and it is probable that, even at the present day, the particulars of the method employed in Russia are not thoroughly known out of that country.

Russia leather consists of calf, sheep, and goat skins, dyed generally of a red color, cylindered, and impregnated with a purified empyreumatic oil obtained from birch-

bark. For this purpose, the whitest and most perfect skins are selected. These are deprived of hair by steeping them in a mixture of ash-lye and quicklime, made too weak to act upon the animal fibres. They are then rinsed, fulled for a longer or shorter time according to their nature, and fermented in a proper steep, after having been washed in hot water. They are taken out at the end of eight days, fulled again, and steeped a second time, if this be necessary to open their pores, and then cleaned with the flesh-knife on both the flesh and grain sides.

A paste is then made, consisting of 38 pounds of rye-flour for 200 skins, and fermented with leaven; and the dough is worked up with a sufficient quantity of water to form a bath for the skins, in which they are soaked for forty-eight hours, then transferred to small pits, and, after remaining therein for fifteen days, are well washed in the river. This preliminary operation serves to prepare the skins for their uniform and complete combination with tannin and extractive matter. A decoction of willow-bark (*salix cinerea* and *salix caprea*) is then made, and, when its temperature is sufficiently lowered to prevent it from injuring the animal fibres, the skins are immersed in it, and handled and worked for a half hour. This manipulation is repeated twice daily during a week; after which, a fresh decoction is prepared, and the skins are subjected to the same treatment in it for another week. After this, they are exposed to the air to dry, and are then ready to be dyed and dressed with the oil.

Another method of preparing the skins for the chief operation is given by Dessables.

The whitest and most perfect skins being selected, are soaked in water, scraped upon the beam, fulled, worked

with the pommel, and then oiled upon the hair side with pure fish oil, and upon the flesh with a mixture of oil and train oil scourings. When dry, they are again pommelled, washed over upon the hair side with a solution of alum, and then pressed under the cylinder. This cylinder, by which the diamond-shaped grain is given to Russia leather, is made of steel, about twelve and a half inches long, and three inches in diameter, and is covered with a number of close parallel threads, or grooves, like those of a screw, but cut perpendicular to its axis, and not spirally. The cylinder is filled with stones weighing from 200 to 340 pounds. It is moved in two directions upon a wooden bench, or support, by means of a cord passing around a wooden roller with a handle. This cord passes also over two cylinders attached to the floor, and a fourth one upon the end of the bench. The cylinder having the handle upon its axle, is divided into two different parts, over which the two extremities of the cord pass in different directions, so that two opposite movements can be given to the cylinder by one handle.

The cylinder is sustained and directed by iron bars placed along the bench upon which it rolls. The skin which is to be grained is placed below it, lengthwise, upon the bench, and longitudinal grooves are impressed upon its surface by the track of the cylinder. The skin is then removed and again placed upon the bench, either crosswise or at an angle, according as it is intended to give it a square or a diamond-shaped grain.

When properly grained, a second coat of alum-water is applied, and when nearly dry, the *Russian oil* is spread over the hair side, and the red or the black color is given. The skin is then repeatedly exposed for a short time to the direct rays of a hot sun, until the color has sufficiently penetrated its substance, when it

is fulled, pommelled, sleeked with the round-knife, upon the beam, and finally well rubbed upon the hair side with a hard brush.

The chief characteristic of the preparation of Russia leather, is its impregnation with the birch-bark oil, the mode of manufacturing which is still, in a measure, kept secret. In order that the oil should penetrate the leather properly, the latter must not be either too moist or too dry, but should contain just sufficient water to enable the oil to be spread equally over the surface, and to be absorbed in proportion as the moisture gradually evaporates. Thus prepared, the leather retains the characteristic odor for a long time. Great care should be taken not to apply too much of the oil, for fear of its passing through and staining the grain side. From twelve ounces to a pound, generally suffice for fully impregnating a large cow-skin. In the case of leather not dyed, or of Morocco to which it may be desired to impart the odor, only a very small portion should be applied to the flesh side.

The composition of the red color with which Russia leather is commonly stained, has not been accurately ascertained. It usually contains Brazil wood, alum, and some other ingredients. It is not very durable, and does not resist the action of boiling water or of potassa, though it generally remains unaltered in the air. Other dyes of better quality are sometimes used, which enhance the price of the leather. The black Russia leather is prepared in the same way as the other, and is stained by the repeated application of the acetate of iron.

Much attention has been bestowed upon the manufacture of the empyreumatic oil of birch-bark, and quite a number of different modes of preparing it have been

described. The following is that given by Fischerstroem as the one practised in Russia.

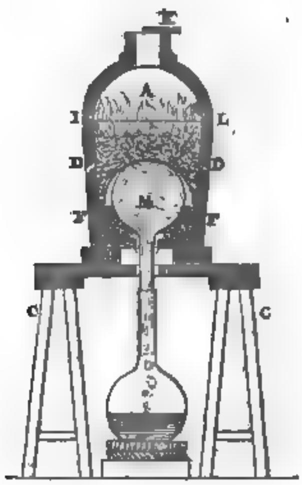
The whitish membraneous epidermis of the birch, carefully separated from all woody matter, is introduced into an iron boiler, which, when entirely full, is covered tightly with a vaulted iron lid, from the centre of which issues an iron pipe. Another boiler, into which this tube enters without touching its bottom, is placed over the other, and the edges are bolted together and tightly luted. They are then inverted, so that the one containing the bark is uppermost. The lower half of this apparatus is sunk in the earth, the surface of the upper boiler is covered over with a lute, composed of clay and sand, and then surrounded with a wood fire and exposed to a red heat until the completion of the distillation. As soon as the boilers are cold, they are disconnected. A light powder of charcoal is found in the upper one, and in the under one, which served as a receiver, a brown, oily, odoriferous, empyreumatic liquid, mixed with tar and pyroligneous acid. This oil is separated from the other substances, and preserved in tightly stopped vessels.

In another method of preparing this oil, the dry birch-bark is introduced into a large earthen pot, having a hole in the bottom. When the pit is full, the bark is set fire to; another similar earthen pot, with a hole for the escape of smoke, is inverted over the first one, and the latter is placed upon a bucket, into which the tar and oily matters drop as they are formed. When the process is conducted in spring, some manufacturers mix the young branches of the birch, covered with buds, with the bark. This arrangement facilitates the separation of the oil, which, when thus prepared, is also of a lighter color, from the smaller quantity of soot contained in it.

The oil is prepared in France, by distilling the birch-bark in copper stills, and condensing the products by means of a worm kept cold by water. About sixty per cent. of the weight of the bark may thus be extracted. The oil obtained in this way, is highly colored and not very abundant, but may be still rectified by re-distillation, so as to be almost perfectly colorless. When thus purified, it is better adapted than the original product, for the oiling of very fine or white leather, which it is important not to stain; but its preparation is costly to the manufacturer, on account of the loss of material, and the small quantity of it obtained.

Another method of distilling the oil, proposed by Payen, is a very simple one, which yielded to him a large quantity of a light-colored product. A hole is made in the bottom of an earthen furnace *A*, Fig. 116,

Fig. 116.



large enough to receive the neck of a matrass *M*. The furnace is supported by two bricks placed upon the plank, which is also perforated so as to admit of the

passage of the neck of the matrass, and which rests upon the trestles *C*. After having filled the matrass to its utmost capacity with birch-bark epidermis, it is inverted and passed through the furnace and the board. The neck is then luted and placed in the position seen in the figure, being supported by sand thrown into the bottom of the furnace as high as *F*, *F*; and in order to expose the body of the matrass to a uniform heat, it is protected by inverting over it an earthen hemispherical cupel, or crucible. Around this burning coals are placed, and the fire is kept up through two lateral openings *D*, *D*, the dome *I*, *K*, *L*, being placed upon the furnace-top. Condensed water first trickles from the mouth of the matrass into a vessel placed beneath, and this is succeeded by drops, and then by a constant stream of an amber-colored oil. After a time this ceases, and it is necessary to apply heat lower down to the neck of the matrass, so as to cause the discharge of the last portions of oil and tarry matters which have condensed in it. The products of the distillation of 1000 parts were:—

1. A fluid, brown, oily matter, very odoriferous, and soluble in ether	700
2. Thick, dark-brown, tarry fluid, containing a little oil	50
3. Water, acidulated by pyroligneous acid	100
4. Light spongy charcoal, left in the matrass	125
5. Loss by the escape of gaseous substances	25

This oil may be more readily prepared by distilling the bark in cylinders of iron, placed horizontally in the furnace similarly to gas retorts.

Chevreul, and after him Payen and Chevalier, have investigated the chemical nature of the odoriferous substance to which the properties of the oil of birch-bark

are owing, and to which the name of *betuline* has been given. The latter chemist found that the epidermis of the bark contains two or three per cent. of this proximate principle, which is a white pulverulent substance, soluble in alcohol, condensing when volatilized into crystalline needles, and giving off, when thrown upon burning coals, a thick white vapor, similar to that of Russia leather but more agreeable.

The leather manufactured in Russia, and elsewhere in imitation of it, is applied to various useful and ornamental purposes; portfolios, surgical instrument cases, pocket, blank, and memorandum books, souvenirs, &c., being covered with it. These articles, and books bound with it, retain the characteristic odor for a long time, and are protected by it from the attacks of mould or of insects.

We conclude this subject by extracts from a memoir by the Count de Kartsoff, on the various methods of tanning employed in Russia.

"The dried skins are softened by soaking in water for five or six days in summer, and ten or twelve in winter; and, after being well cleaned, are deprived of hair by steeping in milk of lime—185 pounds of lime being mixed with the water, in a vat eight feet in diameter, and seven feet three inches in height. The skins are frequently examined, and, when the epidermis and hairs 'give' readily, they are removed upon the horse by the use of a dull two-handled knife, after which the skins are carefully fleshed.

"Strong hides are not freed from hair in lime-vats, but are exposed in a sweating-room, piled up upon each other, and sprinkled over with salt to prevent decomposition; and bran-baths are used for the same purpose in the treatment of certain kinds of thin and delicate skins.

"The skins, after being limed, are well soaked, washed, beaten out with the feet, and rinsed in warm water until the last portions of lime have been removed from them; and they are then *raised* by steeping for forty-eight hours or more in a vat of the dimensions before given, containing a fermented mixture of warm water with 1100 pounds of rye meal, or 450 pounds of oat meal, 6 pounds of salt, and a sufficiency of leaven. Being thus prepared for the tanning, they are steeped for a time in a weak infusion of oak or willow bark, the latter being preferred, and are then stratified in a vat with layers of coarse bark; the vat being filled up with the tanning infusion first used, and its contents being pressed down with planks heavily weighted with stones. The skins are left in this vat for a time varying from fifteen to twenty-eight days, after which they are removed, and again stratified with fresh bark. This operation is repeated from three to six times, according to the nature and quality of the skins—the thinnest kinds only requiring two changes. The stiffness acquired by the leather in tanning is then corrected by soaking them for a day or two in a thin paste, composed, for every 150 skins of ordinary size, of 130 pounds of oatmeal and 9 pounds of salt, mixed with warm water.

"The leather is then well washed, rinsed, and drained, and, while in a partially moist state, is placed upon a large table, with the flesh side up, and coated with oil. This is composed of a mixture of the oil obtained from sea-calves (which abound in the Caspian Sea), and of the pure oil or tar of birch-bark, in various proportions, according to the nature and quality of the leather; one part of the latter to two of the former being generally used. The workman spreads the mixture with his hand evenly and uniformly over the surface, and the perfec-

tion of the operation depends upon the skill with which this is done. About nine ounces of oil are applied to each skin of medium size. When oiled, the leather is then stretched out upon cords in an open shed until perfectly dry, and, in the winter season, is exposed to the cold air, by which its appearance is much improved.

"The Baskirs and Kirguises prepare their skins by smoking in lieu of tanning them. They first stretch them out, in their green state, between stakes fixed in the ground, and then remove the hair by scraping them with a broken sickle fixed in a wooden handle. They then dig a pit in the ground, proportioned in size to the number of skins to be operated upon, and suspend across it parallel cords which are attached to its edges. A round hole is then dug, five feet from the edge of the pit, and is connected with it by a subterranean gutter. The skins are hung upon the cords, the pit is covered over, and a fire of dry rotten wood is lighted in the small hole, the top of which is then closed. The smoke passes through the connecting gutter into the pit, and the skins are kept exposed to its action for two or three weeks, at the end of which time they are found to have acquired properties similar to those of leather, and, above all, a degree of impermeability which does not exist in that which is tanned."

CHAPTER XXXII.

RED SKINS.

When the skins are fresh, they are soaked for eight hours in vats or in running water, and, when dry, besides this soaking, are taken out every day and softened upon the leg. After being sufficiently soaked, they are deposited in a solution, made by boiling and stirring about in water two parts of wood-ashes and one part of fresh quicklime, by decanting this liquid into a vat, and diluting it with a sufficient quantity of water. A grating is placed above the bottom of the vat, so that the skins may not come in contact with the ashes, which sink below the grating.

When the hair is ready to be removed, which usually happens in eight days, the skins are taken out and scraped with the round knife. They are then attached together, two and two, hung on pegs, and exposed to a stream of water, in order to wash away the ashes and lime. After three days, they are taken out, worked on the hair side, hung up to drain, fleshed, and trod out with the feet.

The smaller skins are now soaked during twenty-four hours in a hole or trough, filled with a mixture of dog's-dung and warm water. They are then taken out, cleansed, and rinsed, and macerated for twenty-four hours in a bath made with oatmeal and malt, after which

they are deposited in a tan-liquor, in which they remain three days.

They are then severally sprinkled over with finely powdered oak-bark, and are piled up above the grating of the vat, which is filled with a mixture of equal parts of water and of the tan-liquor. The smaller ones remain in this for eight days, those of a larger size being exposed for a longer time.

After this exposure, they are taken out, rinsed, trod out, fleshed, and replaced in the vats, being each time sprinkled over with powder as before. This series of operations is repeated four times, the skins remaining for three weeks in the vats the fourth time. When properly tanned, they are stretched, dried, and given to the currier to polish and color.

The red color is commonly applied to goat-skins, or the skins of calves under two years of age, and is made of red sandal-wood, while the black is produced by the use of black sandal-wood, 1 pound 2 ounces of the wood being required for a large skin, and about 9 ounces for a small one. To the mixture used to blacken one hundred skins, 2 pounds 9 ounces of green vitriol, or copperas, are added, and an equal quantity of alum is mixed with the red dye for the same number. The skins are sewed around with small stitches, forming sacks which are completely closed, with the exception of the small aperture left for the introduction of the coloring matter. This is poured in hot, the opening is sewed up, and the bag is rolled about in every direction, so that the dye may be brought in contact with all parts of the surface.

When this is accomplished perfectly, the skins are ripped up, dried, and two more coats of color are applied by converting the skin into a kind of roller, and passing it over the coloring matter. After the color has been

sufficiently imparted to the surface, it is daubed over with birch tar or whale oil, and when nearly dry, the lustre is given with a finely grooved pummel, or *grainer*, passed over in both directions. The furrows observable on the surface of this leather, are made by this mode of working. When properly grained, it is dried and sprinkled with hemp-seed oil, and the last polish is given upon the horse.

CHAPTER XXXIII.

WALLACHIA LEATHER.

This kind of leather derives its title from the province of that name, and is made by barley dressings, in a single warm vat. After having been softened in water, the hides are trampled under feet, and then worked on the flesh side with the scraping-knife, so as to render them supple; after which they are rinsed in water, and hung up to drain. Examination is then made, to ascertain if the hair can be easily detached, for, in summer, and warm climates, this is effected without any other preparation. When fresh skins are employed, fermentation is resorted to for removing the hair; and, after the removal of the tail, horns, and ears by the knife, the skins are salted without being soaked. The salting of each large hide consists in sprinkling it over with from four to six pounds of salt, alum, and saltpetre, doubling it in the centre, so that one-half is exactly folded over the other, stacking it, and covering the pile with straw. All being thus arranged, the hides soon become heated, and it is then necessary to turn them once or twice daily, and at the same time to change the folds, and the sides, so as to insure a uniform fermentation throughout. As soon as the hair can be detached readily, the depilation is to be immediately commenced, for any delays might prove injurious to the grain of the leather.

If any unexpected occurrence should prevent the immediate depilation of the hides, they are then to be soaked in water for one or two days, but not longer, for fear of their undergoing incipient putrefaction. It is unnecessary to say that those hides should be first removed, which yield their hair with the greatest ease.

This process can be accomplished without the aid of salt, in the manner already described; as a general rule, the hair should *give* with a noise, when it is plucked out with the fingers. The more difficult this depilation, the better will be the skin, since it is thus proved that it has suffered no alteration by the heating. The parts denuded during or previous to the operation, should be moistened with a solution of salt, so that they may not be overheated before the other portions are ready for depilation.

Depilation can also be effected by means of stable manure. We will, however, mention that the three methods by fermentation are the most objectionable, as the skins nearly always suffer more or less from incipient putrefaction. In following even the method which we are about to describe, it would be much better to employ the exhausted vats, or those which we have already referred to. As soon as the depilation is finished, the raising is effected in the following manner:—

Take for seven skins, each averaging eighty pounds, twenty pounds of wheat flour, make it into leaven, diffuse in water to a pasty consistence, and, to accelerate the fermentation, add besides a gill and a half of vinegar. After this leaven is made, which requires twenty-four hours, it must be kept covered in a warm place for three or four days.

The tub for six or seven skins, should be five and a quarter feet in diameter, and three and a quarter feet in height, and well cleansed, or free from everything ca-

tagonistic to the development of acid fermentation. Having been filled with water, six or seven buckets-full are then withdrawn, boiled, and a part used for making a uniform paste out of ground barley, which must afterwards be thinned out with cold water to the consistence of syrup. This paste is then boiled till it froths, during constant stirring with a wooden paddle, and when it has bubbled or foamed three times, it is to be poured in the tub destined for the dressing, and cooled by stirring with the paddle kept moving constantly in the same direction. Its temperature should not be insupportable to the hand. Six pounds of salt are then to be stirred in, the tub is to be covered, and the contents left for two weeks to sour. It must, however, be stirred twice daily; but in order to confine the heat, the cover should not be kept off, for that purpose, longer than is absolutely necessary.

The skins are then taken from the rinse-water, strung in threes upon a rope thrown into the tub, and there left for four or five days. But on each day they must be withdrawn twice, rinsed, left to drain for a minute, and put back in the tub. Finally, when the skins are well broken, and the hair sides have become sufficiently soft to retain the impression of the finger-nail, they are taken out and fleshed. If portions of the hair should still adhere, the hides are spread upon the beam, or horse, and are scraped with the knife shown by Fig. 117.

Fig. 117.

After being shaved, they are rinsed in clean water, suspended, and left to drain for twenty-four hours. In the mean ti[illegible] leaven, from sixteen pounds of meal,

is made and fermented in the same way as the previous one.

The sour liquor is then transferred from the vat of the first dressing, and the clear supernatant portion poured into the second tub wherein is to be given the *complement*, or completion, which is, in fact, but a repetition of the preceding operation. Six or seven buckets-full of the clear sour water of the tub are taken from each vat, are boiled, and a portion stirred up with about fifty pounds of ground barley, or about eight pounds for each skin. The residue of the hot water is then gradually added, the whole is gently boiled and distributed in the new dressings, well stirred, and a bucket or two taken out and heated nearly to ebullition. The second leaven (made with eight pounds of meal) is then distributed in the tubs; four or six pounds of salt are added to each, and the whole is ultimately mixed by stirring. Several buckets-full should be taken out and held in reserve, so that it may be ready for supplying any deficiency in the quantity of the liquid, which should not be greater than eight inches in height. If this method is too tedious, it may be simplified by making one step of the two, and using at once 30 pounds of leaven, 120 of barley, and 10 of salt, for each dressing of six hides. It must be here observed that, by the ordinary process, the tanners use at one time in their first new dressing, just twice the quantity of barley that would be employed here; and, moreover, when their first new dressing is not sufficient, they are obliged to make a second, which renders the process more tedious and expensive than that of Wallachia. It is also necessary to say that, on the addition of salt, the dressing must always be well stirred, and two or three buckets-full of the liquor drawn out from each, and kept warm to be poured into the vat, in

order to maintain the temperature. Several other buckets-full are also taken out and poured into a reserved tub, so that no more liquor may remain in each dressing than is sufficient to cover the skins subjected to its action. Many tanners believe that it is better to make the whole of the composition at once, for independently of loss of time and fuel, it may so happen that the *complement* made with the new quantity of barley may retard the progress of fermentation, and that the liquor must then be heated to a temperature which would be injurious to the skins.

There are various modes of making the single composition: 1, from barley or rye meal without leaven, prepared over night with boiling water: 2, from equal parts of barley, meal, and leaven, thinned out with water, and heated nearly to ebullition, just previous to putting in the skins: 3, from wheat-bran, in the proportion of a half bushel per hide, thinned out with hot water, and after a day's fermentation mixed with a pound of salt for each skin: 4, from leaven of barley or rye, as substitutes for that from wheat, in the proportion of from six to eight pounds of flour per hide. When the leaven rises, it must be thinned out with water of 86° F., and the salt added just before the skins are put in.

Barley-dressings.—When the fermentation is well established, as may be known by the acidity of the waters, the *dressings* are ripe and ready to receive the skins, which are then taken from the hangers, and passed in and out of the liquor several times, so as gradually to equalize the temperature. After this, they are left upon the cover of the tub to drain for a few minutes. In the interval, the liquor is stirred, the skins are put back, the tubs covered, and the heat of the dressings is main-

tained with the liquor kept warm and in reserve. In fifteen minutes, the hides are a second time taken out and left to drain fifteen minutes, and are then again put back. After a half an hour, they are removed for the third time, left to drain for a quarter of an hour, then returned to the tub, and again taken out to drain for twenty minutes. The fifth time of dipping, they are left in the tub for an hour, and allowed to drain for thirty minutes. Finally, they are taken out again after two hours, and the same round is again repeated a seventh and an eighth time, after a similar interval. The next day, they are taken out twice, and even three or four times if the hides are of bad quality, and do not swell readily. It is necessary to stir the liquor each time, so as to raise the barley-meal from the bottom, and to cover the tubs immediately after putting in the skins. The heat of these tubs should be maintained at from 105° to 120° F., by occasional additions of reserved liquor kept warm over the fire.

The hides are placed in the tubs with the assistance of two workmen, who, taking them by the opposite ends, spread them out upon the flesh sides, and then push them down with a pole.

Experience has proved that the action of the white dressing is completed in about 36 hours; the acetic fermentation, which is established, so expands the hides that they become as thick as the leather into which they are about to be converted. Care must be taken not to leave them any longer in the liquor after this point has been attained, for it injures the leather; a result which also takes place if the liquor be too strong.

After the removal of the skins from the liquor, the clear portion of the latter must be reserved for a new dressing, for which purpose it must be treated with a complement

somewhat stronger than the first. This acid liquor greatly facilitates the fermentation of the new composition, which sours rapidly. In this manner, when the white dressings are once in train, they may be kept at one-half the expense of flour, time, and money.

After being taken out of the dressings, the hides are left to drain on the cover, and as soon as they have cooled, are soaked in water for a few moments, in order to effect the removal of a viscous coating derived from the barley, and they are then drained anew. They are now subjected to the red dressing which prepares them for the tan-vats. This dressing is made by charging the tub with about 40 pounds of crushed bark, into which, mixed with water, the hides are then to be placed. At noon, they are taken out and allowed to drain for seven or eight minutes, and in the evening again for a quarter of an hour; but before they are put back the last time, the liquor must be treated with 40 pounds more of crushed bark, and thoroughly stirred. On the mornings of the second and third days, 24 pounds of bark are added: the hides are taken out three times daily, and an interval of thirty minutes allowed for each draining.

On the fourth day they are taken out only twice—morning and evening. There is no addition of bark, and forty-five minutes are allowed for draining. On the fifth day, the hides are taken out in the morning, and while they are draining, the liquor must be thoroughly stirred, and the hides returned to it, hair side uppermost. Some handfuls of bark are then thrown in between each skin, and on the top of the last one, which should have its flesh side uppermost. The skins are to be left in this state from eight to ten days, then removed, rinsed in clear water, and put into the vats.

This method, though not popular, is still the best in

use, because the strength of the liquors being greater than that of those generally employed, they are less liable to turn, and consequently the work is less tedious.

Bran-Dressings.—Some tanners contend that the red-dressings may be omitted, if the white-dressings are made with bran. The unanimous opinion of many tanners whom we have consulted on the subject, is in favor of red-dressings. However, to complete the consideration of the whole subject, we shall here describe the method employed:—

The bran-dressings are made either hot or cold. For the first, a leaven is prepared with the yeast, or made with 1 to 1½ pounds of wheat or rye flour for each hide, and kept at a moderate temperature.

The skins should be freed from all the adhering dirt and dung which ordinarily soil them; they are then fleshed and dipped. A quantity of water, sufficient for a bath for all the skins, is then boiled with bran, in the proportion of from seven to eight pounds for each skin. The cover is then placed upon the boiler, and when the liquid has been sufficiently *fermented*, which is known by the bran rising to its surface, it is poured into a vat in which the skins, previously rinsed, have been deposited.

While the skins are getting warmed, another quantity of water is heated over the fire until it simmers, when it is mixed with the ferment made at the beginning of the operation. The skins are then taken out from the bath, the fresh mixture is poured into the vat, and is mixed with salt in the proportion of rather more than a pound for each skin; the whole is well stirred, and the skins are then deposited in it. After six hours, the skins are again taken out and replaced, after a portion of the liquid has been previously taken out, heated, and again well mixed with the contents of the vat; and this operation

is repeated every six hours during the two succeeding days.

As soon as the hair is ready to come off, it is removed from the surfaces, after which the skins are passed over lightly upon the flesh, are soaked in cold water for a quarter of an hour, and replaced in the vat, in which they are allowed to remain until sufficiently *raised;* care being taken to keep the vat perfectly covered so as to retain its heat as much as possible. By reheating a portion of the liquor in the vat from time to time, and keeping it warm, the *raising* will generally be completed at the end of three days. The skins are then rinsed and left to soak for some hours in fresh water.

In order to prepare the cold bran-dressings, a ferment is made with 2 pounds, 3 ounces of flour for each skin; it is allowed to ferment, and is then diluted freely with cold water, and the skins are plunged in it. They are taken out two or three times a week, being allowed to drain each time for a whole night, over the vat.

When the hair is ready to be detached, it is removed, the skins are rinsed, passed lightly over on the flesh side, allowed to soak for some hours in water, and are deposited again in the vat, in order to *raise* them. If this process goes on too slowly, they may be exposed to a second bath like the first. This mode of proceeding is very convenient for those who manufacture upon a small scale, as it is inexpensive, and does not require the use of furnaces or boilers. Skins can be readily deprived of hair and raised by it, but it requires exposure for at least two months.

Decomposition of the White-Dressings.—These dressings may be regarded as soured pastes of barley, rye, or wheat, which, under certain circumstances, undergo a decomposition precisely as milk, paper-hangers' paste, and other

substances do, and it is believed that lightning produces this effect as it does in the case of milk. Some tanners are in the habit of placing in the vats scraps of old iron enveloped in linen rags, upon the approach of a thunder-storm, while others dissolve from half a pound to a pound of sal-ammoniac in the vats, under the belief that these means will prevent the injurious consequences of the *turning* of the liquors. When this kind of decomposition takes place in the dressings, they become unfit for further use, and would render the skins so soft, loose and spongy in texture, as to impair the quality of the leather made from them. The long continuance of the summer heats, is also apt to cause this decomposition, and the quality of the dressings is more likely to be injured in the three summer months than in all the rest of the year. Cold has no injurious influence upon them, further than that it diminishes their efficacy, and the skins may be allowed to remain in them even when the surface is frozen, if they are afterwards replaced in fresh dressings.

Rye-Dressings, as used in Transylvania.—The Transylvanian tanners dress their skins almost in the same manner as the Wallachians, except that while the latter employ twenty-two pounds of barley for each skin, the former make use of twenty pounds of rye-flour, divided into two portions of eleven pounds for the first, and nine pounds for the second dressing. This method is less expensive than the other, since the rye grounds preserve their strength much longer than the barley, owing to the greater quantity of gluten contained in them.

CHAPTER XXXIV.

MINERAL TANNING.

By reference to our remarks upon tannin, it will be learned that the chemical property possessed by that body, of forming an insoluble compound with gelatine, is not limited solely to gelatine, but extends also to earthy and metallic bases. This behavior has suggested the employment of mineral agents as substitutes, wholly or in part, for bark, in a way somewhat similar to that in which alum is used for tanning; except that the resulting compound or leather is, chemically considered, a rather more definite combination.

The advantages said to be derived from this mode of treating skins, are superior excellence of the product as to durability and power of resisting water, economy of time and materials, and simplicity of manipulation. These processes, although not strictly tanning ones, will be referred to as such in the following pages, in order to avoid circumlocution.

Of the processes which may be properly comprised under the head of this chapter, some refer exclusively to the use of mineral agents as leather-making materials, and others, to their employment in combination with the usual tanning process.

D'Arcet and Ashton were the pioneers in mineral tanning, and they employed the sesqui-sulphate of iron,

but in such an *unskilful* manner, that their resulting product was very objectionable, being only partially converted into leather, or else having the greater disadvantages of crispness and want of strength.

Bordier followed these experimenters with better success, and in 1842, patented a process of which we now proceed to give an abstract.

BORDIER'S PROCESS.

This method consists in washing, depilating, swelling, and bating or drenching the hides, as is generally done, and then subjecting them to the action of such earthy or metallic salts or bases as the gelatine and albumen may have an affinity for. The tanning agent which the inventor prefers is the subsulphate of the peroxide of iron, which is a compound of sulphuric acid and peroxide of iron, with the latter or base in excess. The impregnating liquor or "ooze" is prepared by digesting twenty-two pounds of powdered green copperas (*proto-sulphate of iron*), with a mixture of two and a quarter pounds of nitric acid at 36° Baumé (specific gravity 1.333), and three pounds one ounce of sulphuric acid at 66° Baumé (specific gravity 1.848). The containing vessel should be a large jar of stone, heated by steam, and the contents must be repeatedly stirred during the digestion. When the red fumes of nitrous gas cease to be given off, the jar is to be removed from the steam bath, and the stirring continued at short intervals, until the mixture is cold and pasty. After twenty-four hours' repose, it is to be diluted with water in sufficient quantity to reduce it to the requisite degree for use, and mixed with an excess of freshly prepared hydrated peroxide of iron. After standing for several days, and being repeatedly

stirred during the interval, the liquor is ready for tanning purposes. In another process described by the inventor, peroxide of manganese is used instead of nitric acid, to *per*-oxidize the *proto*-salt of iron.

By immersion in this liquid, properly diluted, the skins gradually become impregnated with the tanning material. The duration of the soaking should vary with the thickness of the hide. Three days suffice for thin skins, and six to eight for sole leather. In this operation, the subsulphate of iron is absorbed by the gelatinous tissue, while free sulphuric and nitric acids remain in the mother liquor along with any unimbibed iron salt.

In order to impart tenacity, solidity, and impermeability to the leather, it must be subjected to the currier's processes.

CAVALIN'S PROCESSES.

1. *Dutch or Mineral Tanning.*—This process requires that the skins shall be macerated first in a liquor of alum and chrome salt, and subsequently in a solution of protosulphate of iron. The reaction which ensues produces such an interchange of the elements of the iron, chrome salt, and alum, as to generate a new compound or compounds of iron and chrome, which unite indissolubly with the tissue of the hide, and convert it into leather. The preliminary treatment with chrome salt permits the substitution of proto for persalt of iron in the finishing bath, and affords a leather which is impermeable to water, and free from brittleness.

Leather thus made, is brown, tough, and compact, even after considerable soaking, and does not lump under the hammer.

The hides, after having been soaked and undergone the usual preliminary process of depilation, swelling by lime, and drenching, are then thoroughly rinsed in clear water, and hung up to drain. The use of acids must be avoided for swelling, as they are chemically incompatible with the mineral salts used for the tanning, and would, by decomposing them, nullify their action upon the gelatinous tissue of the hide.

In the mean time, a bath is made by dissolving ten pounds of bi-chromate of potassa, and twenty pounds of alum, in one hundred and eighty pounds of water. As soon as the hides have drained sufficiently, they are immersed in this bath for four days, or until they are thoroughly colored and penetrated by the liquid; but with the precaution of drawing them once every twenty-four hours, allowing them to drain, and rubbing them each time before they are returned to the bath. It is also necessary to maintain the original strength of the liquor, by occasional additions of chrome salt and alum, mixed in the proportion of one part of the first, and two parts of the last.

The success of the operation depends upon the completeness of the maceration. Being assured of this, the hides, as above treated, are then subjected to the action of a bath, formed by dissolving ten pounds of green copperas (protosulphate of iron) in sixty pounds of cold water. They must be suspended in the liquor so that they shall not touch each other, and are drawn out at intervals of twelve hours, allowed to drain, and then returned to the liquor, as often as may be necessary for the completion of the tanning. Upper leathers require 5 to 6, Swedish sole, 8 or 10, and American butts, 13 to 19 days' immersion in the liquor. The strength of the bark must be maintained by occasional additions of copperas

throughout the treatment. After coming from the bath, the hides are hung up to drain, then freed from slimy matter, and thoroughly soaked in running water, so as to wash out all uncombined saline matter which would otherwise impair the suppleness and toughness of the leather. The leather is finished in the usual manner.

Upper leather, made by this process, is said to be supple and soft. The *blacking*, however, requires to be differently applied from that employed for oak-tanned leather. In the leather there is always sufficient of tannin to produce a black coloring (tanno-gallate of iron) upon the surface when it is washed over with copperas. In mineral leather, there is no tannin used, nor is there any other material in the tissue of the skin which will, like tannin, in conjunction with iron salt, form the black coloring. The black is imparted by mordanting the leather with a saturated solution of alum, holding in solution eight parts of copperas, and rubbing over a strong decoction of logwood. The leather is then oiled, and finished in the usual manner.

2. *Dye-Tanning.*—This process comprises two series of manipulations, firstly, the dyeing; and secondly, the tanning. It is based upon the fact that gelatine, dissolved in a decoction of Brazil, Heath, Fernambuque, or other dye-wood, is precipitated as an insoluble compound, on the addition of a little chrome salt.

The hides, after having been softened, depilated, and prepared in the usual manner, but *without* the use of acids, are then dipped in a cold dye-bath, made by exhausting the dye-wood in a steam-vat, and adding alum to the solution in the proportion of four ounces to the gallon.

"Skins and upper-leather hides are first dyed in the grain in a we lye, composed of one volume of

the above strong dye-lye and four volumes of water. While this dyeing is going on, the skins and hides must be frequently stirred. After thus lying for twelve hours, they are then hung up until they have nearly lost their moisture, when they are laid in the strong lye, stirred there well three or four times a day, till they are dyed all through, a light yellow green in the grain, and green yellow quite through. Sole-leather hides, which need no stirring, are also first laid in the weaker liquor for twelve hours, and then in the strong lye, some dye-wood being placed between every hide, that they may not touch too closely. The hides may then remain undisturbed until they are sufficiently dyed through, a small bit of the uppermost hide being cut off every now and then to see how the dyeing is progressing. When circumstances demand it, the strength of the lye can be tested by immersing therein a softened bit of raw skin, and taking it out after some hours to see whether it is dyed light yellow green or only yellow; for in the latter case, the liquor is too weak, and wants either more dye strength or some alum. It must then be drawn off, and a new lye poured on. The lye which has been drawn off is now tried again, and refreshed by the addition of 1-48 of alum.

"If a piece of raw-done skin is only dyed yellow in this lye, it must then be boiled again with dye-wood, and some alum added to it in the manner above described. If the bit of skin, on the contrary, is dyed green yellow, the mixture need not be reboiled with dye-wood, but only increased in strength by the addition of 1-48 to 1-32 of alum."

The hides are then hung up to drain previous to being immersed in the chrome bath, which consists of a solu-

tion of 10 pounds of bichromate of potassa in 180 pounds of cold water.

The requisite time for the completion of the soaking, is about twenty-four hours; but it is necessary to handle the hides frequently, and to draw and allow them to drip three or four times during the treatment. The bath must also be refreshed by occasional additions of chrome salt.

The action of the chrome salt effects the tanning, and, with the assistance of the alum, darkens the color of the hides. After coming from the chrome bath, they are hung up to drain, carefully smoothed, thoroughly soaked three several times in fresh or running waters, for 12 to 24 hours, then cleansed on the beam, and suspended in the drying-room. They are then dampened, stretched, worked on the flesh side with train oil; half dried, again stretched, and blacked on the surface as directed in mineral tanning.

It is doubtful whether leather made by any of the preceeding processes will preserve its durability for any length of time; as, from its very nature, it would be reasonable to expect it to crack, unless it be kept constantly greased. It possesses this advantage, however, that when worn by long service, the debris are still useful as glue pieces, for they may readily be reconverted into their original condition of raw hide, by the removal of the basic salts which maintain them in the state of leather.

NEWTON'S PROCESS.

This method, patented in 1849, is an accelerating process, somewhat analogous to the preceding. It consists in the employment of [illegible] , or

metallic salts for the preliminary treatment; and of catechu, sumach, oak-bark, or other astringent matter for the tanning. The joint action of the salts and the tanning material promotes the combination of the albuminous matter of the skins with the bases, and subsequently, of the gelatine tissue with the tannin. When other material than catechu is used, the latter of good quality, and containing 50 per cent. of tannin, is taken as the standard for regulating the proper proportion of the former. The skins must be unhaired, and free from lime.

For 100 calf-skins.

$\begin{cases} 20 \text{ pounds Alum, and} \\ 10 \quad \text{“} \quad \text{Common Salt;} \end{cases}$

100 " Catechu;

4 " Sulphate of Alumina, either alone or mixed with 2 pounds common salt.

The three mixtures are dissolved in water, and kept apart in separate vessels.

Of the first solution, one-fifth; of the second, one-tenth; and of the third, one-fourth are placed in a vat. The skins are then immersed in this liquor, and repeatedly handled or stirred about for a short time, after which they are taken out. The vat is then refreshed by the addition of one-fifth of the first solution, one-tenth of the second, and one-fourth of the third, and the skins replaced in the mixture, and treated as before, but for a longer interval. The skins being removed a second time, the vat is again refreshed with one-fifth of the first solution, and one-tenth of the second; and the skins re-immersed in it as in the previous instance. After remaining for some time, and being handled occasionally, they are again removed, and the residues of the first and third

solutions, and one-fifth of the second are poured into the vat. The skins are then put back, but in a few days are again taken out to allow the addition to the vat of the remaining two-fifths of the second mixture. Four or five weeks suffice to complete the tanning of the skins.

The author suggests that the process may be modified by laying the skins in a vat, and stratifying them with 3 lbs. of moistened tan. The constant contact of the tanning liquor would have to be maintained by pumping it from the bottom of the vat to the top of the skins.

This process is applicable to the tanning of other skins, but the proportions of materials require to be varied, as follows: The proper quantities for

One hundred goat-skins, are

Alum . . .	10 to 12 lbs.
Salt . . .	6 lbs.
Catechu . . .	50 to 60 lbs.

For one hundred cow-hides, are

Sulphate of Alumina .	2 to 300 lbs.
Salt . . .	100 lbs.
Catechu . . .	500 "

For one hundred and ninety ox-hides, are

Sulphate of Alumina .	14 to 16 lbs.
Salt	8 lbs.
Catechu . . .	60 to 70 lbs.

Sulphate of magnesia or chloride of zinc may be substituted for sulphate of alumina.

CHAPTER XXXV.

THE TEXTURE AND QUALITY OF LEATHER, AND THE MEANS OF DISCOVERING ITS DEFECTS.

It is evident from what has already been observed, that well-tanned leather is a homogeneous substance, entirely free from unchanged gelatine or fibrine. But if the bark used in its preparation has been deficient in tanning ingredients, or otherwise wanting in quality; if the various processes have been imperfectly or carelessly performed, or if unforeseen accidents have occurred, the excellence of the leather is impaired; and this is generally to be discovered by making a section of it. Well-tanned leather exhibits, when cut, a shining surface and compact body; is of a uniform color, excepting upon the hair side, and has a nutmeg appearance internally. These signs are commonly looked for in the tail, the back, and the neck, which are the thickest parts of the skin.

Badly made or inferior leather is commonly detected by its section being of a yellowish or blackish color, alternating with streaks of a black or whitish hue, and by its structure being loose and deficient in density and compactness.

Too long a continuance in the tan-vats or lime-pits, badly prepared or applied "dressings," want of moisture in the pits, and a number of other circumstances, give

to leather a spongy and loose texture, and render it deficient in the requisite color and durability. These defects are of such a nature that, when once tanned, the leather cannot be improved or restored to a better condition.

It is impossible to thoroughly tan those hides which are thin, poor, and weak, and such, in general, as, either from natural defects or want of correct management, cannot be properly *raised*.

Other conditions of skins, unfitting them in a measure for the tanning process, arise from injuries received in the slaughter-house, from soaking in muddy or slimy waters; from foreign matters imbedded in the hair side, which subjects their surface to bruises when they are being worked on the beam, and from weakness of texture, owing to incipient decomposition, by a too long exposure in the lime-pits. Old moss-covered bark, which is full of cracks, charged with moisture, also injures the quality of leather. The opposite and equally injurious circumstance of deficient watering of the pits, has already been sufficiently censured.

Notwithstanding the arguments hazarded by some tanners in favor of the use of the impure waters of certain localities, there can be no doubt of the fact that the freshest and purest water that can be employed, is the best for the preparation of leather.

Manufacturers differ among themselves in opinion about the effect produced by cold weather upon their leather; some contending that it softens the tissue, and that it is only necessary to expose poor and thin skins, and those which are otherwise difficult to manage, to cold, in order to make them soft, and put them in a condition to be worked. Others maintain that extreme cold, by congealing and expanding the water contained in

the tissues, extends and separates the particles, and thus impairs the body and firmness of the leather.

Some hides are called *horny*, parts of which, from want of proper softening, are dry, and almost as hard as horn; and these are entirely unfit for shoe or boot leather, as the tan has not perfectly penetrated the hard parts. Others contain extremely minute perforations made by worms, which allow water to filter through, and render them useless for either sole leather or carriage-tops. Many hides are injured by the carelessness of the butchers, who damage the flesh side by a reckless manner of skinning. These imperfections can only be remedied by shaving the surface down to a uniform thickness, with a scraping knife, at the risk of making the hide thin and weak.

Shoemakers using sole leather, which has been made from hides damaged upon the hair side, either in depilating, in paring, or in rinsing them, should be careful to place the flesh side out; otherwise, as soon as the hair surface has become a little worn, the sole will become spongy, and easily absorb moisture.

A common mode of determining the quality of leather, is to allow a drop of water to fall from the end of the finger upon the hair side, or upon a cut surface; if the drop preserves its circular form, and does not extend, the leather is supposed to be well tanned, while if the water is soon absorbed, it is regarded as an evidence of its substance being spongy and badly prepared. A better test is to allow a piece of the leather, the weight of which has been accurately ascertained, to soak for some days in water. If, after being taken out, it is found considerably increased in weight, no better proof of its being spongy and loose in texture, and consequently imperfectly prepared, could be desired.

It is believed, by some, that leather is improved in quality, by age, and it is a common reproach against shoemakers, that they make use of too fresh materials. Exposure for a certain length of time is doubtless advantageous, but leather is not improved by being kept longer than two years, and is apt after this time to dry and to diminish in weight, making it necessary to store it in damp cellars. The resistance and durability of the leather made into soles of boots and shoes, are much increased by their being laid aside for some time before being worn.

The coloring of leather during the process of tanning, arises from a dark brown substance, existing more or less in the infusions of tanning materials, and called by Berzelius, *apothème.* This sparingly soluble substance is generated by the oxidation of extractive matter, and is gradually formed when infusions of tanning materials are exposed to the air, all the varieties of tannin being, to a certain extent, liable to this transformation. Hence it is, that the uppermost hide of the vat, being the most exposed, is the most highly colored.

This color, or "bloom," as it is technically termed, varies somewhat with the kind of tannin employed. For example, leather tanned with material containing the gall variety of tannin is bloomed with *ellagic acid,* and that made from catechu tannin is bloomed with *catechuic acid,* both of which coloring matters are derivatives or products of the decomposition of the tannins respectively employed.

Spent liquors or weak *handlers,* yield less "bloom" than the strong "bloomers," which are richer in tannin.

"Bloom" attaches itself, permanently, to the animal tissue, and even penetrates beneath the surface, to a limited depth, imparting both color and weight to the

leather. The fawn color is the favorite bloom, but a darker shade does not necessarily indicate an inferior leather.

In the modern or quick processes, the tan-liquor being exposed for a much shorter time, yields less bloom than by the old and lengthy methods of tanning. Consequently, as time is an important element in the formation of this substance, its absence is considered an evidence of the inferiority of the leather, and that it has been tanned too rapidly to be good.

CHAPTER XXXVI.

TAWING.

THE tawing process is applicable to the manufacture of soft leathers for gloves and furriers' use, as skins may be subjected to its action even in their hair state. The prepared product sometimes takes the name of "alumed leather," because a salt of alumina is the basis of the process. Sheep, lamb, kid, and other light skins are those usually subjected to this treatment.

Kid Leather.—The first step in the *aluming* of kid skins is to soak them well in running water, and then to "break" them upon the beam by working on the flesh side with the back of the fleshing-knife. After this treatment, drying must immediately ensue, to prevent putrefaction, which would render them spotted and tender. Dry skins require soaking for at least one or two days.

The next step is to rub the flesh sides with cold milk of lime, place them back to back in pairs with the hair outwards, stack these pairs in piles, and thus leave them for several days until the hair "gives" readily. They are then rinsed in running water to remove lime, and subjected, at once, to the fleecing operation, which consists in "plucking" out the hair with spring tweezers, and smoothing by rubbing with a whetstone or rolling-pin. A further cleansing and soaking is then given by

an immersion, as before, in the lime-vat, whence, after being removed, they are transferred to an old or weaker vat, and there remain for a fortnight or more, care being observed to take them out, and drain them frequently.

They are now ready for the *branning;* and for this purpose undergo a steeping, for ten or fifteen days, in a fermenting mixture, or "drench," of forty pounds of bran and twenty gallons of water. As soon as the skins sink in water, they are sufficiently *raised;* and this requires two days in summer, and double that number in winter; and great care is necessary to observe when they reach that stage, which may be attained much earlier by frequently turning the skins during the steeping.

When taken from this liquor, they are to be put into the "white-bath," composed, for one hundred skins, of a boiling solution of twelve to eighteen pounds of alum in twelve gallons of water, to which must be added of common salt, two and one-half pounds in summer, and three pounds in winter.

The mode of working this bath is to divide the skins into four equal parcels, and to pass each parcel, separately but successively, through the bath, and then to immerse the whole together for ten minutes.

A paste is then made by gradually adding, during careful and constant stirring, firstly, fifteen pounds of wheat flour to the above alum-bath gently heated, and subsequently, the yolks of fifty eggs, and then incorporating the whole thoroughly. The skins, after being passed through this paste singly, are then transferred to it in bulk, and left for a day.

The paste has an emulsive action, softens and whitens the skins, counteracts the hardening influence of after exposure to the air, and tendency to brittleness.

After the action of the paste, the skins are stretched

upon poles in a drying loft, and there left for a week or more, as may be necessary. They are then ready to be worked upon the *softening iron*, in order to stretch them, reduce unevennesses, and develop whiteness. To this end, they are soaked in water for five or six minutes, and then spread and softened by the process of *staking*.

They are next stretched on hooks, dried, and worked on the *stretching iron;* but some French tanners, previous to these operations, and just after the skins come from the smoothing iron, spread them upon the beam with a clean, undressed skin beneath, and work them with the fleshing-knife.

Occasionally, the prepared skins are polished by being rubbed with pumice. The lustre and finishing stroke are given with a smooth flat-iron, carefully heated, and managed in the same way as that used by a laundress.

In some places, the tanning process is slightly modified. For example, by the use of a large barrel-churn, or *roundabout*, which receives both the skins and alum-bath. Rapid rotation of the apparatus promotes constant contact of the skins and tanning material, and thus accelerates the operation.

The tanned skins, after coming from the egg paste, and being washed and dried, are subjected to what is technically termed *staking*. This consists in the use of a semicircular iron plate, fixed perpendicularly, with its round edge uppermost, to the top of a wooden stake about thirty inches in height. The workman, holding the skin distended by both hands, draws it forcibly (Fig. 118), and in every direction, over the blunt edge of this tool, and thus imparts softness and smoothness to it.

Color can be imparted with dye-stuffs, as may be desired.

Fig. 118.

The tawed leather is the raw skin combined with subchloride of aluminum. This latter salt is formed by mutual decomposition of the ingredients of the alum-bath. For example, the common salt, which, chemically speaking, is a compound of chlorine and sodium, when mixed with alum, which is composed of sulphuric acid and oxides of aluminum and potassium, gives up its chlorine to the aluminum. This latter base having deserted its oxygen and sulphuric acid, they in turn take up with the potassium and sodium, and form sulphate of potassa and sulphate of soda. These remain in solution in the water along with a perchloride of aluminum, the neutral chloride first generated being converted, in its reaction upon the animal tissue, into a subchloride which combines with it, and a perchloride which is soluble. The salt also aids in whitening the skins.

Imitation Kid.—Imitation kid leather is made from lamb-skins. In order to remove the wool without injuring it, lime is not used for depilation. After the skins have been steeped in water, and "broken" on the

flesh side, they are suspended in a subterranean vault about twelve feet square, protected as much as possible from the influence of external atmospheric changes, so that the temperature within may continue uniform throughout the year. An incipient putrefaction being thus promoted, loosens the roots of the wool, which may then be readily plucked from the pelt; and as soon as this state is reached, which is generally in from five to seven days, the skins must be immediately removed, for a continuance of the fermentation would injure their texture.

The skins are then *slimed*, as it is termed, or scraped on the fleshed side; stripped of wool, and steeped for a week, more or less, in lime-water, fleshed on the beam, *drenched* for some days in a fermenting bran-bath, and then treated with alum and salt in the same manner as for true kid leather. Dyeing, softening, and polishing complete the preparation of the leather.

Housings and Mats.—Skins are frequently tanned with the hair on, for housings and mats, and for furriers' use. Sheep, lamb, calf, and goat skins, may each be treated by this process, in which, consequently, lime and liming must be dispensed with, as it would prove injurious to the hair. The skins are soaked in water until clean and soft, are then thinned on the flesh side with the fleshing-knife, and steeped for several days in an old bran-bath, and washed. They are then folded with the hair sides in contact, immersed in the alum-bath, as before directed, and spread over, upon the flesh side, with the egg paste. After remaining in this state for eighteen to twenty hours, and becoming stiff, they are hung up to dry. They are next sprinkled with cold water, folded, and stacked, and put under a pressure of heavy boards for two days. After being opened with a round iron, upon

the beam, and worked breadthwise on the stretching iron, they are dried by exposure of the fleece side to the sun, and finished upon the stretcher.

Eighteen pounds of alum suffice for 100 sheep-skins; but as the thickness of the skins increases, the quantity of tanning material must be augmented. A calf-skin, for example, requires one pound of salt and one pound of alum.

CHAPTER XXXVII.

HUNGARY LEATHER.

The Hungarian method of preparing skins, which is analogous to tanning, is said to have been originally introduced into Hungary from Senegal. It was carried into France in 1573, by Boucher, a tanner. In the next century, Colbert, the great patron of the industrial arts, gave particular encouragement to this process, and established a manufactory at St. Cloud, in which it was adopted. This establishment was removed, in 1702, to la Roquette, Faubourg St. Antoine, where it was for a long time in successful operation.

Hungary leather is manufactured by a rapid process, which consists in impregnating strong hides with alum, common salt, and suet, and which is almost the same at the present day as that originally employed when first introduced from Hungary; only one improvement upon the method having been since proposed, that of Curandeau, which will be described in the proper place. The leather is manufactured at all seasons of the year, any injurious influences which temperature might exert upon it, being counteracted by measures which the experience of the workmen leads them to adopt.

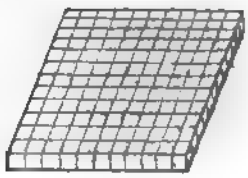
The workshop in which skins are prepared by this method, consists of two parts. One of these is a shed on the banks of a stream, in which are placed the beams,

the fleshing and paring knives, and the scraping stones. In one corner is a furnace with a boiler for preparing the solution of alum, and near it are placed two tubs for immersing the skins. Besides these, a number of ordinary tubs are required.

The other part of the factory consists of a room 6½ feet high, and 16½ feet square, made perfectly tight, so as to retain the heated air. In one corner of this apartment is a furnace, which is fed with fuel through a door opening externally, and upon which is placed a copper boiler, capable of containing about 180 pounds of tallow.

In the middle of the room is a square stone, upon which an iron grating, 3½ feet square, is placed for the reception of coals (Fig. 119). On either side of the

Fig. 119.



room, and occupying its whole length, are large tables, upon which the skins are greased. The upper part below the ceiling is filled with poles, upon which the leather is hung in order to be heated and dried. The door of the apartment fits closely to its jambs, so as to prevent the entrance of cold air.

The chief operations to which hides prepared after the method of Hungary are subjected, are the following:—

1. The cleaning, dipping, and rinsing.
2. Aluming.
3. Second aluming.
4. Drying.

5. Stretching.
6. Treading out.
7. Tallowing.
8. Flaming.
9. Airing.
10. Weighing, marking, and piling.

These operations will be successively described under their appropriate headings.

Strong ox-hides are the most suitable for the leather of Hungary, but bull and cow skins may be prepared for particular uses. The process is a rapid one, and may be completed in two months or less time. Hungarian hides can scarcely be compared with those tanned and curried in the ordinary way, since they consist of the original tissue of the skins, condensed, and slightly altered in character, by the processes to which they are subjected, but not converted into true leather by combination with tannin. Moreover, they are usually employed for different purposes.

1. *Preparation of the Hides.*—The first operations are analogous to those of tanning and tawing. The hides are washed, cut in half, scraped upon the horse with a round or curved knife, and are then carefully and slightly fleshed, the fat and flesh alone being removed, this and the succeeding operation being confided to the most skilful workmen.

The hair is then scraped off from the hides, by placing them upon a bed of other skins, folded double, and so disposed upon the horse (Fig. 120) as to present a smooth, and perfectly uniform surface. This operation must be conducted with the utmost care, to avoid injuring the surfaces, and a whole day will be occupied by a single workman in separating the hair from eight or ten

Fig. 120.

hides. The skins are then put to soak in the river for twenty-four hours, or, if in vats, for three days; the water, in that case, being changed twice a day in summer, and once daily in winter. If soaked in running water, a stake is driven into the ground and the hides are fastened to it by cords passing through the eye-holes, or those left by the removal of the horns.

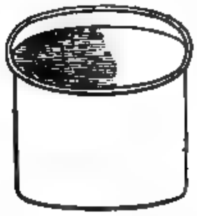
2. *Aluming the Hides.*—The preparation with alum is the most important one to which Hungary leather is subjected. It not only prevents the putrefaction of the hides, but effects a chemical change in them by which they are rendered stronger and more substantial. The exact nature of this chemical influence is not known, but the supposed reaction is as explained under kid leather.

The hides are first treated with a mixture of alum and common salt, by which a portion of the sulphate is converted into chloride of aluminum. The salt softens the effect of the alum, attracts the moisture of the atmosphere, and preserves the suppleness of the leather.

When the hides are ready for the operation, the aqueous solution of alum and salt is made in a boiler fitted into the furnace. This boiler (Fig. 121), should be pro-

portioned in size to the number of pieces of hide which are to be alumed in a single operation.

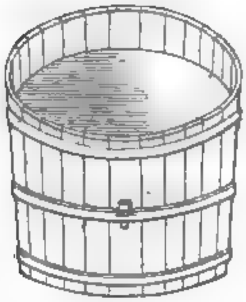
Fig. 121.



Six pounds of alum, three and a half pounds of salt, and nearly eight gallons of water are used for a piece of hide weighing from seventy to eighty pounds.

The water is first heated to about 122° F. The alum and salt are then thrown in, and the whole thoroughly stirred until they are dissolved. The vats (Fig. 122)

Fig. 122.



are two in number, placed side by side, and each about five and a half feet long, a yard wide, and two feet eight inches deep. When nine hides or eighteen strips are worked together, they are divided into three lots of six strips each. Three strips are placed in each vat, being prepared upon each other with the hair side up, and so arranged that the head of the second one is above the tail of the first, and so on. Two or three buckets-full of

the alum liquor, tepid but not hot, are now thrown into each of the vats, and the skins are tramped upon by the workmen, walking in bare feet with a stamping motion repeatedly from one end of each vat to the other; the uppermost hide when well tramped, being pushed backwards and forwards from one end of the vat to the other. The upper hide, after having been stamped, is folded up and removed, so that the second, and after it in due course the lower hide, may have the benefit of the same treatment, to which end the stamping must be repeated as many times as there are hides. The alum liquor is then dipped up from the vats, and thrown into the boiler, which has been kept heated. When the temperature has risen rather higher than that of the liquor first used, two or three buckets-full are again poured into the vats, and the same process of tramping is repeated. The hides are trod out in a similar manner, a third and a fourth time, in liquor reheated and replaced in the vats as before, its temperature being more and more elevated each time.

After the fourth tramping, the hides are folded double, and deposited in tubs two feet eight inches in diameter and the same in height (Fig. 123), and the alum liquor which has already been used is poured over them. The hides remain immersed in the alum water for eight days; their position being changed every day or two. They are steeped for a much longer time in winter by some manufacturers. But no difference need be made in this respect between the seasons.

Fig. 123.

3. *The Second Aluming.*—After being removed from the tubs, and well shaken to remove the folds, the hides are subjected to the same round of operations as in the first aluming. They are steeped for twenty-four hours

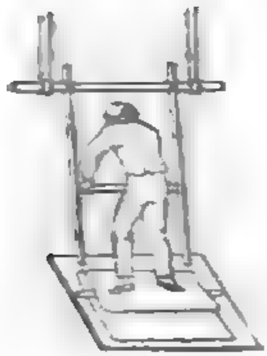
in the same alum water, and are taken out, and left to drain on planks which are arranged in a slanting position, so that the fluids escaping from the hides run back into the vats.

4 and 5. *Drying and Stretching.*—When the alum water has ceased to drop from the hides, four holes are made in each strip, and a stick is thrust through them, which is supported by its two ends upon poles near the ceiling of the drying-room. The hides are left suspended in this way until three-quarters dry. They are then taken down, and laid out upon the floor, being folded double, with the hair sides within. A workman stretches all its parts, and takes out the wrinkles which have formed in it by forcibly drawing a stick two feet long and about two-thirds of an inch in diameter in every direction over the surfaces. The hides are then piled, and after remaining in that state for a day or two, are again suspended upon the poles, and thoroughly dried.

If the weather be cold during the drying process, the hides should be hung for a time on the poles in the stove-room before described, and should be warmed by lighting a charcoal fire on the grate. After becoming sufficiently warm, they may be stretched and piled upon one another, and should in that case be covered with cloths to protect them from the effects of the cold. Thus alumed and dried, Hungary leather will keep as well as that which has been tanned, and it is only necessary to avoid exposure to a hot sun or to warm, dry winds, in order that it may not become so dry as to be worked afterwards with difficulty.

6. *Treading out the Hides.*—The leather when quite dry is softened, and prepared for receiving the tallow by a peculiar method of stamping. A platform (Fig. 124) is erected, consisting of planks, slanting in one direction,

Fig. 124.



and supported upon crosspieces or rafters twelve to thirteen inches apart from each other. The strip of hide to be worked is folded double, with the hair side in contact, and a smooth stick of hard wood (Fig. 125), twenty-six

Fig. 125.

inches long and three-quarters of an inch in diameter is passed through it. The workman, having his feet covered with thick-soled shoes without heels, then stands upon the folded strip, which is laid upon the upper part of the platform, and holding on to a railing or post, proceeds to roll the stick by repeated stamping and shuffling movements of his feet from its first position to the edge of the strip. This is repeated again and again, the position of the stick being changed, and the strip of hide being turned until every part of the latter is well tramped. The leather is then folded in the opposite direction, so that the flesh side shall be in contact, and is exposed again to the same stamping process. The operations should be continued until the piece becomes as soft and supple as it is possible to make it. The strips of hide are then piled upon each other for a time, and if not sufficiently dry when taken down, are exposed to a hot sun or to the heat of the drying-room; after which they

are trodden out a second time, precisely in the same manner as before.

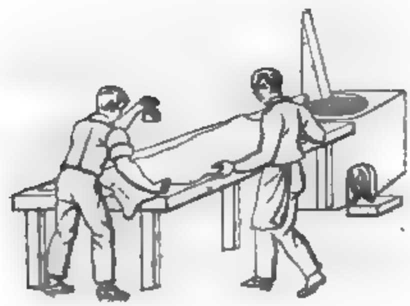
7. *Tallowing the Hides.*—The strips of hide are impregnated with suet in the stove-room, which has already been described, and the tallow is melted in a boiler capable of containing about one hundred and seventy pounds. This is one foot eight inches deep, and two feet three inches in diameter, and is imbedded in the masonry of the furnace (Fig. 126).

When the hides are ready to be greased, the boiler is three-quarters filled with tallow, and is heated until the latter melts. When it has attained a degree of heat a little above the melting point, it is ready for use. In the event of the heat being too great, and of the boiling over of the tallow, the draught must be lessened, and lumps of cold tallow must be thrown in. While the tallow is being melted, a fire is kindled upon the grate, with a basket-full of charcoal. The basket used to contain the fuel is twenty-one inches in height, and the same in diameter.

As soon as the charcoal is kindled, from twenty-four to thirty-eight strips of hide, according to their size, are folded double, and then stretched across the poles below the ceiling of the room, the largest and thickest being placed nearest to the fire. The workmen then leave the stove-room, closing the door tightly behind them, in order to escape from the stifling vapors proceeding from the hides, and the noxious carbonic acid from the charcoal, and do not return until they are assured, by experience, that the heating has been carried far enough. They then, after airing the room a little by opening the door, enter it with no clothing but short aprons, and proceed to examine the leather. When sufficiently warmed, a white appearance, beginning at the extremities, and extending

over the whole surface of the hides, is observed. As soon as this is the case, the strips are removed from the poles, and stretched out upon each other, with the flesh side uppermost, on the table (Fig. 126) near the boiler. The

Fig. 126.



tail or thickest parts of the hides are placed nearest to the boiler, and the smallest and thinnest strips, or those which were the most removed from the fire in heating, are made to occupy the lowest position in the pile.

Two workmen are employed in tallowing the hides. The one who is nearest to the boiler, takes off the uppermost strip of the pile, and folding it double, with the flesh side out, and the head placed upon the tail, assures himself, that the tallow is heated to the proper point. He then takes a tallowing cloth or mop (Fig. 127), made with pieces of woollen rag or blanket-stuff, a foot long, and tightly tied around a wooden handle six inches in length, and having immersed it in the boiler long enough for it to become saturated with the melted fat, rubs it over the head part of the flesh side until that half of the surface is sufficiently *fed*.

Fig. 127.

He is assisted by the other workmen with a similar mop, and when one-half of the leather is properly

greased, it is extended out at full length by the two workmen, and the whole of the flesh side is saturated with the grease. The strip is then turned over, and the hair side is greased with the tallow still adhering to the mops, which are not dipped again in the boiler, for this purpose, for fear of injuring the surface by the heat of the melted tallow. When well greased throughout, the strip is laid out upon the table upon the opposite side of the room, with the flesh side up. The skins are in like manner successively greased and piled upon each other on the table, until the end of the operation.

One hour is usually occupied in preparing thirty strips. Grease of an inferior quality, such as the residuum of melted tallow and kitchen stuff may be employed, and about three pounds of it are required for each piece of leather.

It is probable that workmen are exposed in no one of the arts, to more fatigue and danger than they are compelled to encounter while conducting the operations of the stove-room. Constantly inhaling the suffocating vapors from the skins and the melted tallow, and the dangerous carbonic acid given off from the charcoal fire, they are exposed to the risk of suffocation, or at least to that of great irritation of the lungs; while the profuse flow of perspiration from the whole surface of the body debilitates and predisposes to taking cold. Precautions should be taken by them to leave the room as soon as the charcoal fire is lighted, and not to re-enter it until the skins are sufficiently warm, and until the atmosphere has become somewhat changed by a current of fresh air entering through the open door. The workmen should not go into the heated apartment with full stomachs, but should commence the operation two or three hours after a meal, and in quitting work, should immediately leave

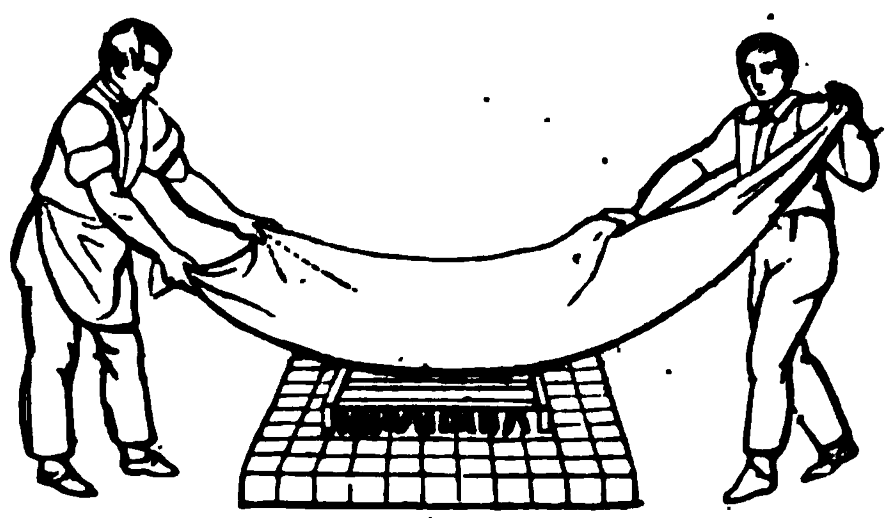
the place, and rub themselves down with a coarse towel before resuming their dress.

Buzzing or tinkling noises in the ear, giddiness, and headache, are regarded as premonitors of the dangerous effects of the inhalation of carbonic acid, and upon the occurrence of these, the men should immediately leave their work, and go out into the fresh air. The most dangerous part of this process might be entirely avoided by heating the stove-room by means of hot air. A heating apparatus for this purpose has been proposed by M. Curandeau. It consists of an oval-shaped stove, two feet high, not including the supports, and three feet in diameter. The interior consists of a cast-iron hearth paved at the bottom with bricks, and adapted for burning wood. The smoke and heat ascend through a pipe two feet long and five inches in diameter, and are conducted into a vertical pipe or column, three feet high and eleven inches in diameter. From the top of this, two smaller pipes diverge, and are connected with two other vertical columns, each two feet ten inches in height, and nine inches in diameter, which are placed at the side of the main column; and with the lower ends of these two pipes, a fourth horizontal one, placed two inches above the top of the stove is connected, and into this the smoke and heat finally enter, the former to escape through a chimney, and the latter to be given off to the air of the room.

8. *Flaming the Hides.*—The hides are left for a time to imbibe the tallow with which they have been impregnated, and are covered with cloths in order to prevent the unequal action of the fire upon them. A fire is then kindled upon the grating, with a basket-full of charcoal; the workmen leave the room, and after about a half an hour, open the door to allow the escape of gas, and entrance of fresh air. The charcoal being in full combus-

tion, two workmen then enter, and taking the uppermost strip off the pile, one by the head and the other by the tail, stretch it in every direction over the fire, with the flesh side down, and continue this for at least a minute. The strip is then extended upon the empty table with the flesh side up, and the same process is repeated with the other strips of the pile. When the flaming (Fig. 128) is finished, the newly made pile of hides is

Fig. 128.



covered over with cloth, and left for a half hour in summer, and three hours in winter. The heat to which the hides are exposed in this flaming, is necessary for their complete penetration by the tallow; but it may be applied in a different way. Thus, some manufacturers light a large fire in the room, and keep the skins exposed to its heat with the door closed for a half hour or more.

9. *Exposure to the Air.*—After the hides have remained in pile, for about three-quarters of an hour, they are wiped upon both sides with a dry rag or mop, in order to remove the excess of tallow, and are then hung upon poles in the air, with the flesh sides up, and the heads and tails depending. They acquire firmness and consistency by this exposure, if they are not under the direct influence of the sun's rays. If prepared in summer, they should be tallowed shortly before sundown, so

that when ready to be aired they need not be exposed to the heat, but may be cooled by the night air. In winter this precaution is, of course, unnecessary. Airing during the night in summer, and for thirty hours in winter, is sufficient to prepare the hides for the last operation.

10. *Weighing, Marking, and Piling.*—The hides are weighed after the airing last described, and most of them are found to have lost nearly one-half of their original weight in the operations to which they have been subjected, and some of them to have experienced more than that amount of loss. The weight of each strip is marked in Roman characters upon the tail, and the hides are piled up in a place which is neither too dry nor too moist; and after remaining thus for some days they are in a proper condition to be delivered to the harness-makers or other consumers.

Hungary leather can be prepared for the market in fifteen days in summer, and in three weeks or a month in winter. A fine strip of hide weighs, usually, about thirty pounds, and is valued at about forty cents the pound.

Hungary Leather made of Cow and Calf Skins.—Cow-skins are occasionally prepared in the Hungarian manner, but they are deprived of hair by liming instead of scraping. They are left in the lime-pits for eight or ten days until the hair is ready to come off. It is then removed, and the skins, after being washed and scraped until the last portions of lime have been separated, are prepared exactly in the same manner as thick hides, excepting that they are not exposed for so long a time to heat in the stove-room, before being tallowed. They are rendered spongy by the liming, and are disposed to

absorb a larger quantity of alum and salt in proportion to their weight, than ox-hides.

Calf-skins are prepared in the same way, but absorb much less proportionate quantities of the materials used. A large calf-skin will require about eighteen ounces of alum, nine ounces of salt, and a pound of tallow.

Hungary Leather made of Horse-Hides.—These hides are not worked when dry, but are taken in the green state; and in order to prevent the inequalities of surface which would otherwise be found upon them, they are not thoroughly fleshed, but a part of the membranous substances is left upon their flesh sides.

They are first cut in half and put to soak for twelve hours, after which they are fleshed with a sickle-shaped knife, and deprived of hair by liming, first in an old pit for one day, and after intervals of two or three days, during which they are kept piled up, in a second and third weak lime-pit for three days. After being deprived of hair, they are soaked for twelve hours in summer, and twenty-four in winter, with occasional stirring, in order to remove the lime. When perfectly clean, they are scraped with the stone, and dressed upon the hair side with the round-knife. They are then rolled up from head to tail and put aside to drain for six hours.

They are trodden out in the vats, like other hides, with three alum-waters only, the tails and manes being beaten more forcibly than the other parts. About five and a half pounds of alum, and two and three-quarter pounds of salt are required to impregnate each large horse-hide. After being stamped, they are placed in the tubs with alum-water, and remain in them from two to eight days, and are then tramped upon again in the same liquors. They are then drained, partially dried, stretched out with the hands, dried entirely, and worked

upon the platform like ox-hides; after which, they are heated upon the poles of the stove-room, for from a quarter to a half hour, according to their degree of dryness, and when thus heated, they give off vapors so offensive, as to be scarcely endurable. They are then tallowed and finished in the ordinary manner; but require only half the quantity of grease which is used for ox-hides.

Hungary leather made of horse-hides, is often mistaken for, and sold with that prepared from ox-hides; but it is much inferior to the latter, being apt to harden and shrink, and being much less firm and strong.

Hungary Leather prepared in Imitation of Blackened Leather.—A patent was taken out in the year 1836, by Kresse, for the following method of preparing black Hungary leather:—

The hides or skins intended to be blackened, are taken when fresh, and a mixture of orpiment and lime, with water, is spread over the flesh side and left in contact with it for two hours. At the end of this time, the hair is taken off, and the skins are passed during some days through baths of tan, alum, and salt. They are then half dried, softened, suppled, and dried. After being greased with boiling tallow, and again soaked in water, they are stretched upon the table, and the color is applied upon the hair side.

The surfaces are first rubbed over twice with stale urine. The third and fourth applications consist of a color made with decoctions of three parts of logwood and one part of fustic, and the fifth and sixth of alder bark, iron rust, and nutgalls, mixed with lemon-juice. After receiving these different coatings, the skins are dried, and smoothed by stretching upon the table. For making the color of the last two applications, 100 spoiled lemons

are squeezed into a bucket-full of broken pieces of alder bark, mixed with ten pounds of scraps of rusty iron, and one pound of bruised nutgalls. The contents of the bucket are stirred up, and left for fifteen days, at the end of which time the liquid is poured out, and is ready for use.

The skins are apt to become mouldy before being colored, if piled up in a moist place, and in order to prevent this occurrence are prepared in the following manner:—

After being washed in the river, and before being alumed, they are placed in a vat, and covered with warm water, with which a bushel of bran and four ounces of ferment for each skin, have been previously mixed. They are steeped for three days in this bath, and are afterwards alumed, and trod out three times in warm water, to remove the salt, before being dried.

In order to give the skins a brown color similar to that of tanned leather, after being tallowed, they are steeped for some days in tan-liquor. If it is desired to blacken them, they may then, after receiving the four first dressings mentioned above, be brushed over twice on the hair side with a solution of copperas, instead of the mixture prepared with lemon-juice.

CURANDEAU'S PROCESS.

Curandeau, believing that the change experienced by the skins in the saline bath is due chiefly to the sulphuric acid of the alum, proposed the substitution of oil of vitriol for that salt. The skins, after passing through the preliminary processes, are, when treated in this way, macerated for twenty-four hours in a bath consisting of twenty pounds of salt dissolved in twenty-five gallons of

water, and mixed with four pounds of sulphuric acid at 66°. They are then taken out, dried, and finished in the ordinary manner. Curandeau believes that as much progress is made by the skins in this bath in twenty-four hours as by those which are exposed for a much longer time to alum baths, and that they possess all the best qualities of Hungary leather. The advantages of the process are, that the same bath answers for numerous sets of hides, the loss of salt and acid being replaced each time; the superior cheapness of the acid, and the fact that the necessity of heating the liquor, and of working the skins in the laborious way required when alum is used, is avoided.

Uses of Hungary Leather and the Causes of its Defects.—Hungary leather is chiefly employed by harness-makers and carriage-makers for different parts of harness and for main-braces of coaches.

Hides of the best quality, as recognized by the signs which have already been described in treating of the tanner's art, should alone be converted into Hungary leather. Horse-hides, intended for this manufacture, should be taken fresh from the slaughter-house, since even the commencement of putrefaction will diminish or destroy the fineness of the hair side to which this leather owes much of its beauty and usefulness.

Leather which has been imperfectly tramped during the aluming process, or which has only been treated with two or three waters, cannot be properly worked upon the platforms. It will not absorb as much tallow as is necessary for it, and is apt to contain hard and horny portions which are calculated to diminish its strength and flexibility. Those hides which have spots of extravasated blood upon their surfaces, should be rejected as being weak and of bad quality.

CHAPTER XXXVIII.

OILED LEATHER.

Under this head that kind of leather is classed, which is distinguished from all others by being prepared without tannin or alumina, and by having the grain surface of the skin removed. Fish oil is the preservative substance employed, but it exerts no chemical action upon the animal tissue. The skins are made to imbibe the oil by mechanical force, which expels and volatilizes the moisture and with it such putrescent matters as are soluble in cold water. All tendency to decomposition is thus entirely prevented.

Oiled leather is commonly known as *chamois*, or *wash-leather*. It derives its first name from that of the wild goat of the Alps, from the skins of which it was originally made; and the last from its property of bearing wetting and washing without suffering injury. It is also called *losh* leather. In former times, when it was generally employed as material for the clothing of the troops and peasantry in European countries, the manufacture was very extensive. The facility with which it becomes damp, and the difficulty and slowness with which it dries, together with the chilling effect upon the body, and consequent injurious influence upon the health, have, of late years, caused its disuse for that purpose, and materially reduced the trade in the article. Its use

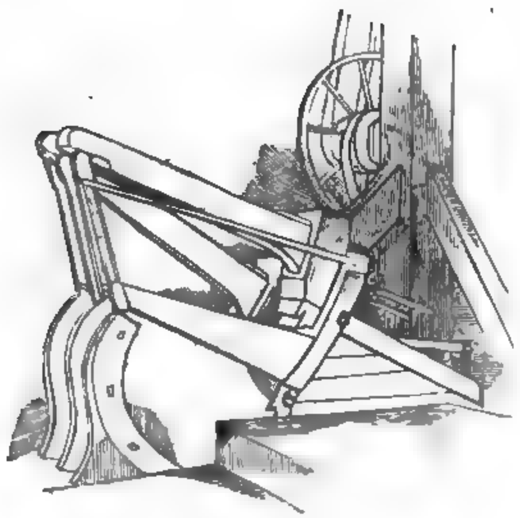
is now almost exclusively limited to domestic purposes, being employed chiefly for washing and polishing furniture, &c.

The preliminary preparations of this leather are the same as for tanning, and the process is equally applicable to goat, sheep, lamb, deer, and the thin sides of split skins; care being necessary, however, to select the finest and most perfect.

The skins, after having been brought to the state of *pelt* by washing, liming, fleecing, beaming, and branning, in the same manner as for kid leather, are subjected to what is technically termed *frizing*, which is a rubbing with a pumice stone, or working under the round edge of a blunt knife. This manipulation removes the "grain surface," equalizes the thickness of the skin, renders it pliable, and exposes a softer surface.

The skins are then wrung out, transferred to the trough of a fulling mill (Fig. 129), and subjected to the

Fig. 129.



continuous action of the wooden hammers until nearly dry, when they must be removed, spread upon the table, and severally sprinkled on the grain side, with cod or any kind of fish oil. Being now folded in bundles of four, they are returned to the trough, and beaten as before, for from two to four hours, as may be necessary to produce perfect impregnation with the oil, after which they are again taken out, opened, exposed to air for a short time, and then besmeared with grease, and fulled as before. These manipulations must be repeated eight or nine times, or until the skins become thoroughly imbued with the oil. From three to five gallons suffice for one gross of skins, which is the number generally placed in the trough at one time.

After the oil has been well beaten into the pores and there is no appearance of greasiness, the skins are taken out, and suspended by hooks, to wooden hangers running across a drying chamber about six feet high and twelve feet square, kept warm by steam-pipes, or the carefully managed heat of a stove. This treatment causes a slight fermentation which dilates the pores, and promotes the intimate incorporation of the oil with the animal fibre. Moreover, it has a beneficial influence in destroying any remaining decomposable constituents of the skin.

The excess of oil is removed by immersing and handling the skins for an hour in slightly heated potassa lye, of 2° Baumé, which converts it into soluble soap. They are then wrung at the peg, dried, finished first on the stretcher, and then on the *horse*, and lastly smoothed with rollers.

When it is desired to impart a buff color, they are merely dipped in an infusion of oak-bark, which in this case serves as a dye, and not as a tanning stuff.

The fulling mill used in this manufacture consists of two stocks, the head covered with copper, being attached to a long beam or handle lying in an inclined position. Near the lower end of each, a wheel revolves, by which each hammer is raised and dropped through a space of about a foot into the trough beneath. The upper or handle end of each stock is adjusted so as to work on a pivot or axis; and the stocks being set in action, the two descend and rise alternately at regular intervals, and beat the skins uniformly until they are perfectly dry.

NISBET'S PROCESS.

Mr. John Nisbet, of England, recommends the substitution of machinery for the hand in the laborious process of grounding, or frizing, and has invented for that purpose a very ingeniously constructed apparatus. He employs knives and pumice stones, or other sufficiently rough materials, set into revolving cylinders which are made to turn in contact with the surfaces of leather. Fig. 130 represents a side view; and Fig. 131 a longitu-

Fig. 130.

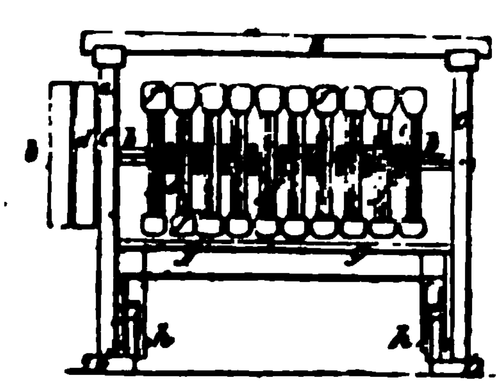
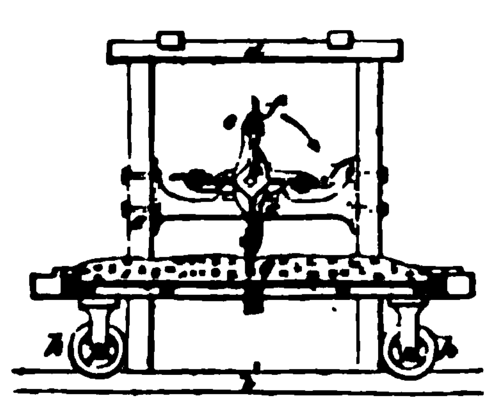


Fig. 131.



dinal section of one of these machines; *a a*, framework; *b*, axle turning in the supports *c c*, and made to revolve by means of a strap around the pulley *d*; *e e*, series of crosspieces, or arms, each of which is provided with a paring-knife *f*, which, by the revolution of the shaft, is

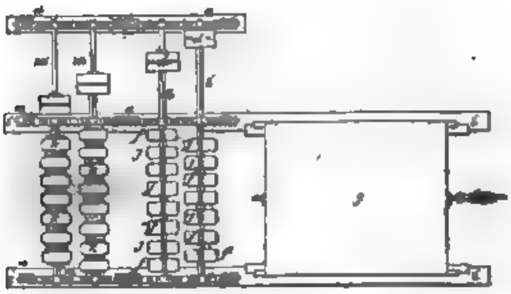
brought in contact with and made to pare the surface of the skin or portion of skin placed on the mattress *g*. This mattress is stuffed with hay or other suitable material, and is covered with oiled leather. It is placed upon the top or table of a car mounted on four grooved wheels *h h*, which run on the railroad *i i*.

The arms which carry the knives are made to revolve at least 360 times in a minute, and the rapidity of motion can be increased if it is desirable to do so.

The workman places the skin, or portion of skin, upon the mattress, and pushes the car forwards, so that the end of the piece shall be under one of the series of blades. These latter, by their revolution, then draw the leather away from the workman, and pare its surface while he retains the extremity in his hands and retards its progress more or less, according to the amount of action to which it is desired to expose it. When one side is thus pared throughout, the band is slipped off from the pulley, so as to stop the revolution of the axle, the car is drawn back, the leather turned, and the strap being replaced, the other side is made to undergo the same treatment. Besides great rapidity, this operation secures a uniform paring of the leather.

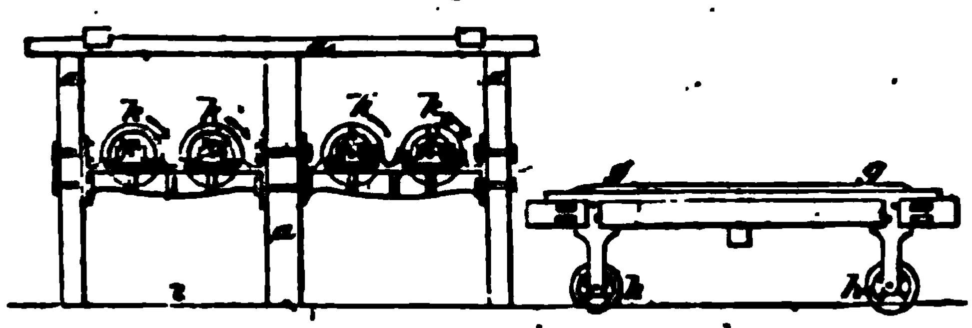
When light and thin skins are treated in this manner,

Fig. 182.



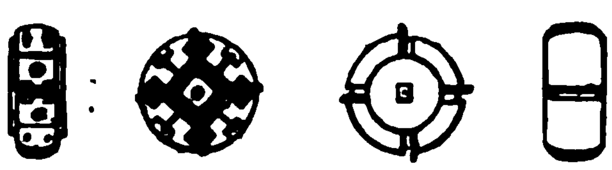
the intervals between the knives are filled up with wooden blocks, or wedges, so that the axle is surrounded by a compact cylinder of wood, beyond which the knives project only to a slight extent. Fig. 132 shows the plan, and Fig. 133 the side view of the machine so modi-

Fig. 133.



fied; and Figs. 134, 135, 136, and 137, exhibit a front view of the arms and knives from between which the wooden wedges have been removed; a section; a side view; and front view of the series of knives *f*, and of the wedges *j*.

Figs. 134. 135. 136. 137.

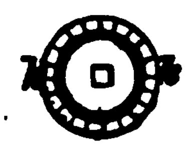


Figs. 132 and 133 also represent the apparatus for *pumicing* leather. The pumice stones *k*, or other suitable rough substances, are attached to the shafts *m*, which are made to revolve by the ordinary means. In other respects, the machine resembles the preceding one, the same letters indicating corresponding parts of both.

The leather submitted to the action of this machine, is first pared by means of two sets of knives *f*, which are represented in the figure as turning upon two shafts, and it then passes under the *pumicing* cylinders, which act progressively upon every part of the surface. Figs.

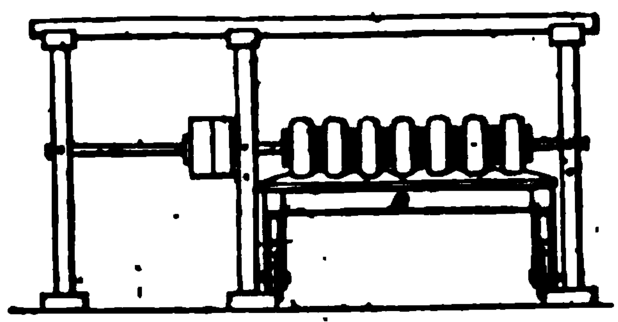
138, 139, and 140 exhibit, the first a section, the second

Figs. 138. 139. 140.



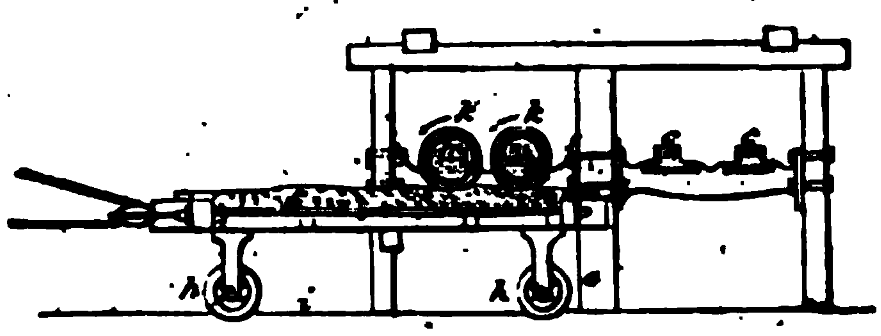
a side view, and the third, a front view of these cylinders and stones. Figures 141 and 142 show, the one a

Fig. 141.



cross section, and the other a longitudinal section of the pumicing machine while in action.

Fig. 142.



CHAPTER XXXIX.

TANNING AS PRACTISED BY THE CALMUCKS, OR MONGOL TARTARS.

The Calmuck women prepare the skins of young lambs by rinsing them in warm water, stretching and exposing them to the air until half dry, scraping them upon the flesh side, and again partly drying them, upon the grass.

They then rub them over three times a day, for three days, with sour milk, in which a little salt has been dissolved, and dry them upon the fourth day, working them constantly with the hands and over the knees, until they become supple. When thicker skins are prepared in this way, they are softened by means of a kind of brake with grooved edges.

The skins are then smoked, in order to make them impervious to water. For this purpose, a fire is lighted in the bottom of a small pit, and rotten wood, dried dung, pine cones, and any substances which produce a thick smoke are thrown in as fuel. Sticks are erected in a pyramidal form around the pit, and the skins are hung thereon, one above the other, their position being occasionally changed, so that those which are underneath at first are placed outside in their turn. This smoking is kept up for an hour or more; those skins which become stiff are worked to render them pliable;

and when the operation is concluded, they are rubbed on the hair side with chalk or powdered gypsum, scraped, whitened again with chalk, freed from hair, and beaten.

Goat or sheep skins, intended for garments, are rolled up when fresh, and laid aside until the wool detaches itself, and then rubbed with sour milk, and treated in the same manner as lamb-skins. They are finally rubbed over with a strong decoction of statice root, with which a little of alum and mutton-suet has been mixed; dried, and rubbed again and again with the same mixture, until its brownish-yellow color has penetrated the whole skin. These skins resist moisture exceedingly well.

Those of the Calmucks who are engaged in the Russian fisheries, make the skins of the large sea-carp into garments to protect them from the rain. They dry the skins, remove the scales, and prepare them with sour-milk, or a decoction of statice root.

Their hollow utensils, for domestic purposes, are all made of ox-hides and horse-hides. These are boiled in water until the hair can be readily detached, or else are deprived of it by means of ashes, and then scraped and rinsed in running water and dried in the sun. Before they are quite dry, they are cut into pieces, sewed by women into the desired form, stretched into shape, and smoke-dried. These vessels retain an unpleasant odor, and easily soften, but by exposing them for a number of days to a thick smoke, they acquire almost the transparency of horn, and become so firm and solid that they last a great length of time.

TANNING AS PRACTISED BY THE AMERICAN INDIANS.

The following method was communicated to the Royal Society of London, by Sir Robert Southwell.

As soon as the skin is removed from the animal by these aboriginal leather-dressers, it is stretched and dried. The brains are at the same time taken out and also dried upon the grass, by exposure to the sun's rays. When the season of the chase is over, the squaws soak these skins in water, remove the hair from them with an old knife, and place them along with the brains, in a large earthen pot; the contents are then heated to about 95°, which converts the moistened brains into a kind of lather, and makes the skins exceedingly clean and pliable. They are then taken from the pot, wrung out, and stretched in every direction, by means of thongs, over a frame composed of upright stakes and crosspieces; and while drying they are constantly rubbed with a smooth stone, or hard rounded piece of wood, so as to expel the water and fat. One squaw can prepare eight or ten skins in a day.

CHAPTER XL.

SHAGREEN.

GENUINE shagreen of the best quality is manufactured almost entirely in Astracan and other parts of Asiatic Russia, where it is prepared by the Tartars and Russians. Fine gray shagreen, as well as that of other colors, is imported from Constantinople, and the white of a good quality is obtained from Algiers and Tunis. A very inferior article is also manufactured in Poland. The genuine oriental shagreen is not a true leather, but a skin prepared by drying, and without the chemical action of any tanning material.

The particulars of the manufacture of shagreen have not been ascertained with certainty, but the following process is that which is said to be pursued in Astracan.

The skins of horses, asses, and camels are the exclusive raw material; and only the small strip from the crupper along the chine to the neck, can be employed. This is cut off just above the tail, in a semicircular form, about thirty-four inches upon the crupper, and twenty-eight along the back. These strips are soaked in water, until the hair is ready to come off, when it is separated by scraping; and the pieces, after being again steeped, are dressed with the fleshing-knife until all the extraneous matter is removed, and they have been reduced to the thinness of a hog's-bladder. They are then stretched tightly across frames, and occasionally dampened to pre-

vent them from shrinking unequally; after which, they are laid on the floor, with the flesh sides undermost, and the grain sides are then thickly strewed over with the smooth, hard seeds of the *alabuta*, or goose-foot (*chenopodium album*). Instead of these, mustard seeds are used in some places. A felt is then laid over the whole, and the seeds are forced deeply into the soft moist skins by treading upon them, or by the action of a press. The characteristic mottled or granular appearance of the hair side of shagreen is given to it by this operation.

The frames, with the seeds sticking in the skins, are then dried slowly in the shade, until the seeds are ready to drop off upon shaking; and the skins, which are thus converted into hard, horny membranes with the surfaces deeply indented, are laid upon a block or beam, padded with wool, and are shaved down until the depressions caused by the seeds become very slight and uniform. The skins are steeped first in water, and afterwards in a warm alkaline lye, and are piled upon each other while still warm and moist. By this means, the parts indented by the pressure of the seeds regain their natural elasticity, and, not having lost substance by the shaving of the rest of the skins, they rise to or above the surrounding level, and form the peculiar grain of the shagreen. After this, the skins are cleansed by salt brine, and dyed.

The beautiful green dye is given to shagreen by passing a concentrated solution of sal-ammoniac over the flesh side, strewing it over with copper filings, rolling it up with the same side inwards, and pressing each skin for twenty-four hours with a heavy weight. The sal-ammoniac dissolves enough of the copper to give the skin a beautiful sea-green color.

Blue shagreen is dyed with indigo dissolved in a solution of soda, with lime and honey; the black, with nutgalls

and copperas; and the red, with decoction of cochineal. Pure white shagreen is made by dressing the strips first with alum solution, and then with wheat dough, and washing away the latter with alum water. Greasing, careful working in hot water, currying with a blunt knife, and drying, complete the preparation.

Shagreen is rendered very hard by drying, but, like parchment, it softens in water, and in that state will take any shape given to it, and is used by sheath-makers for the cases of spectacles, lancets, mathematical instruments, &c.

There is an imitation shagreen which is so much like the genuine article that it is almost impossible to distinguish the difference. For the purpose of manufacturing this article, sheep or goatskins, after being deprived of hair in the lime-pits, are steeped in water, fleshed, soaked again, and well rubbed down upon the horse with a hard, polished piece of wood, after which they are steeped a third time, and beaten out and trimmed on both sides. They are then steeped for two hours in a bath made of a bucket-full of tan for every fifty skins, mixed with water enough to cover them; a bucket half full of the same being thrown in at the end of an hour, and another at the end of an hour and a half. After this, they are kept in tan-pits for eight days, and, when removed from them, are wrung out, and reduced in thickness by the use of the round-knife applied upon the horse. They are then half-dried, well stretched in the direction of their length, cut in half, blackened in the ordinary manner and dried.

The grain is given to this false shagreen by means of copper plates which have been engraved in imitation of the roughened surface of the real article. These plates, previously warmed, are placed upon the skins, and then su of a press.

CHAPTER XLI.

PARCHMENT.

Parchment is the invention of Eumenes, king of Pergamus, in Asiatic Turkey, about 200 years before Christ. It was known in early times, as *Pergamena*, and was used, on account of its great durability, for records and valuable manuscripts, and as a substitute for the *papyrus*, or writing-paper of the ancient Egyptians. The finest quality, made from thin and perfect skins, and prepared by very careful manipulation, is called *vellum*.

Fine parchment, for writings, is made from the skins of calves, kids, stillborn lambs, sheep, and she-goats; but an inferior quality, for drum-heads and battledores, is prepared from the skins of he-goats, calves, wolves, and asses. Pig-skin is also sometimes converted into parchment for bookbinders' use. The operations are nearly the same, throughout, for all the varieties, but are more delicate for the finer quality.

The skins above mentioned are those generally employed for this branch of manufacture, but all other thin skins are applicable; and sometimes the thinner halves of thick hides, split by machinery, are dressed by this process.

"The skins, after having been soaked, limed, shaved, and well washed, must be set to dry in such a way as to prevent their puckering, and to render them easily

worked. The small manufacturers make use of hoops for this purpose, but the greater employ a *horse*, or stout wooden frame. This is formed of two uprights and two crossbars, solidly joined together by tenons and mortises, so as to form a strong piece of carpentry; which is to be fixed against a wall. These four bars are perforated throughout with a series of holes, which are fitted with very smooth and slightly tapered box-wood pins. Each of these pins is transpierced with a hole like a violin screw, by means of which the strings used in stretching the skin may be tightened. Above the *horse*, there is a shelf for such tools as the workman may need at hand. In order to stretch the skin upon the frame, large or small skewers are employed, according to the size of the piece which is to be attached to it. Six holes are made in a straight line to receive the larger, and four to receive the smaller skewers, or pins. These small slits are made with a tool like a carpenter's chisel, and of the exact size to admit the skewers. The string round the skewer is affixed to one of the bolts in the frame, which is turned round by means of a key, like that by which harps and pianos are tuned. The skewer is threaded through the skin when in a state of tension.

"Everything being thus prepared, and the skin being well softened, the workman stretches it powerfully, by means of the skewers; he attaches the cords to the skewers, and fixes their ends to the iron pegs, or pins. He then stretches the skin, first with his hand applied to the pins, and afterwards with the key. Great care must be taken that no wrinkles are formed. The skin is usually stretched more in length than in breadth, from the custom of the trade; though extension in breadth would be preferable, in order to reduce the thickness of the part opposite the back bone.

"The workman now takes the fleshing-tool, which is a semi-circular double-edged knife, made fast into a double wooden handle, seizes it in his two hands so as to place the edge perpendicularly to the skin, and pressing it carefully from above downwards, removes the fleshy excrescences, and lays them aside for making glue. He now turns round the *horse* upon the wall, in order to get access to the outside of the skin, and to scrape it with the tool inverted, so as to run no risk of cutting the epidermis. He thus removes any adhering filth, and squeezes out some water. The skin must next be ground. For this purpose, it is sprinkled upon the fleshy side with sifted chalk or slaked lime, and then rubbed in all directions with a piece of pumice-stone, four or five inches in area, previously flattened upon a sandstone. The lime soon becomes moist from the water contained in the skin. The pumice-stone is then rubbed over the other side of the skin, but without chalk or lime. This operation is necessary only for the best parchment or vellum. The skin is now allowed to dry upon the frame, being carefully protected from sunshine and from frost. In the warm weather of summer, a moist cloth needs to be applied to it from time to time, to prevent its drying too suddenly; immediately after which, the skewers require to be tightened.

"When it is perfectly dry, the white color is to be removed by rubbing it with the woolly side of a lamb-skin. But great care must be taken not to fray the surface; a circumstance of which some manufacturers are so much afraid as not to use either chalk or lime in the polishing. Should any grease be detected upon it, it must be removed by immersion in a lime-pit for ten days, and by then stretching it anew upon the *horse*, after which it is transferred to the *scraper*.

"This workman employs here an edge tool of the same shape as the fleshing-knife, but larger and sharper. He mounts the skins upon a frame like the *horse* above described; but he extends it merely with cords, without skewers, or pins, and supports it generally upon a piece of raw calf-skin, strongly stretched. The tail of the skin being placed towards the bottom of the frame, the workman first pares off, with a sharp knife, any considerable roughnesses, and then scrapes the outside surface obliquely downwards with the proper tools, till it becomes perfectly smooth. The fleshy side needs no such operation, and, indeed, were both sides scraped, the skin would be apt to become too thin, the only object of the scraper being to equalize its thickness. Whatever irregularities remain, may be removed with a piece of the finest pumice-stone, well flattened previously, upon a piece of close-grained sandstone. This process is performed by laying the rough parchment upon an oblong plank of wood, in the form of a stool; the plank being covered with a piece of soft parchment stuffed with wool, to form an elastic cushion for the grinding operation. It is merely the outside surface that requires to be pumiced. The celebrated Strasburg vellum is prepared with remarkably fine pumice-stones.

"If any small holes happen to be made in the parchment, they must be neatly patched, by cutting their edges thin and pasting on small pieces with gum-water.

"Parchment is colored only green. Boil 8 parts of cream of tartar and 30 parts of crystallized verdigris in 500 parts of rain-water; and, when this solution is cold, pour into it 4 parts of nitric acid. Moisten the parchment with a brush, and then apply the above liquid evenly over its surface. Lastly, the necessary lustre may be given with white of eggs, or mucilage of gum Arabic."

CHAPTER XLII.

LEATHER BOTTLES.

In some of the southern districts of France, leather bottles are very important objects of manufacture, as they are in general use for carrying oil and wine. Cowskins are used for the purpose, and those from Mezin, and the mountains near Puy, are said to be the only ones fit for the manufacture. They are carefully dried upon pegs by the butchers, and are then softened in lime which has already been used, and in which they remain for eight days. They are then thrown into a fresh lime-pit, until the hair readily comes off, are cleaned, rinsed and fleshed, after having been cut into pieces of the proper shape. They are now exposed to dry upon a smooth, clean, and dry spot of ground, great care being observed that this drying takes place uniformly and very gradually, the rays of the sun and any excess of heat being prevented from affecting them. Having thus been deprived of moisture, at the same time that they preserve all their suppleness, they are hung up for a month and exposed to the direct rays of the sun, being taken down and stored at night, so that no moisture shall have access to them.

Before being sewed, they are placed in water to allow the stitches to be made. These bottles last a long time,

but liquids kept in them, nearly always acquire an unpleasant taste.

TANNING OF THE SKINS OF SHEEP'S LEGS, FOR MAKING TUBES WITHOUT SUTURE, FOR COVERING THE CYLINDERS USED IN COTTON AND WOOL SPINNING.

Delvau, a Parisian tanner, took out a patent of invention for this purpose, which is described in Vol. IV. p. 296, of Expired Patent Reports. His process consists in cutting the skin of the sheep's-foot circularly above the spur, and stripping it off in a manner similar to that after which rabbits are uncased. This tube, thus made, is then limed until the wool falls off, is *daubed* with oil, and curried so as to make it of an equal thickness throughout.

To apply the leather tubes upon the cylinders without suture, two burnishing tools are used for spreading them out. Each tube, which is made of such a size as to exceed the cylinder a little in diameter, is then drawn over it; and stretched upon it by means of pincers, and the parts which pass beyond the ends of the cylinder are folded down, smoothed out, and glued over them. These extremities are then rubbed with the burnishers, in order to make the glue enter the substance of the leather, and they are left to dry for five or six hours. The shreds of leather are then removed, and those parts which project from the middle and ends are cut away on a turning lathe. To finish the surface, and give it lustre, it is then well rubbed with a hard linen cloth.

CHAPTER XLIII.

ENGLISH PROCESS FOR TANNING NETS, SAILS, AND CORDAGE.

A SHIP-BUILDER of Bridgeport has proposed the following method of preserving and increasing the strength of nets, sails, and cordage. A hundred pounds of oak branches and the same quantity of tan are boiled in 89 gallons of water, until it is reduced to seventy-one gallons. The solid materials are then taken out, and the articles to be tanned are deposited in the liquid, care being taken that they are entirely covered by it, and do not rest upon the bottom of the vessel. They are boiled for three hours, and are then taken out and dried.

This, though a true tanning process, can scarcely be likened to the ordinary ones for preparing leather, since its object is a combination of tannin and extractive matter with vegetable substances, which are very different from the gelatine of skin. According to Millet, linen which had been steeped in an oak-bark liquor at 150° F. for two or three days, remained unaltered in a damp cellar for ten years, while an untanned piece entirely rotted under similar circumstances.

CHAPTER XLIV.

GLAZED, OR VARNISHED LEATHER.

THIS leather, known in commerce as *patent leather*, is very largely used for dress boots and shoes, and for fancy mountings. There are various methods of manufacturing it, but the following are those most generally employed:—

Two distinct operations are resorted to in the manufacture of polished leather, one of which is the preparation of the surface for receiving the varnish, and which is effected by closing the pores of the leather, and making a proper ground by repeatedly rubbing the surface with pulverulent substances, and incorporating them with it; and the other is the varnishing of the leather thus dressed with suitable brilliant and transparent materials.

The basis or medium of the substances used for both these purposes is linseed oil, made drying by boiling with metallic oxides or salts, and reduced to a syrupy consistence by the prolonged action of heat.

Five gallons of linseed oil are boiled with four pounds four and a half ounces of white lead, and the same quantity of litharge, each in a state of fine division, until it becomes of the consistence of thick syrup. This mixture is then intimately united with one of the ochres, or with powdered chalk, according to the fineness of the

skins which are to be prepared, and is uniformly spread upon either side of the leather, and well worked into the pores with appropriate tools. Three very thin coats of it are applied in the same manner, at sufficiently long intervals to enable them to dry between the different applications, and the surface is then forcibly and uniformly rubbed with pumice-stone. A number of thin coatings of the preparation are then applied in a similar manner, and rubbed down as before until perfectly uniform, and of a sufficient thickness to prevent the varnish from penetrating the leather, by which its quality would be injured, and its structure rendered hard and brittle. The oily substance of the preparation and of the varnish should merely penetrate deeply enough into the leather to make the compositions of which it is the basis adhere closely to it.

The foundation for the varnished surface being thus laid, a mixture of the preparation before used, without, however, the addition of ochreous or other earthy matters, and well rubbed up with fine ivory-black and enough spirits of turpentine to make it flow smoothly and easily, is laid on by means of a fine brush; three or four successive coatings being applied. By this means, a black and shining pliable surface is obtained, over which, as soon as it is perfectly dry, the varnish may be applied.

The leather is dried after the application of each coat, by hanging it up, or, what is better, laying it out upon frames or racks in the drying-room. It is customary before the varnishing, to give a polish to the surface by rubbing it over with a piece of woollen stuff and the finest kind of pumice powder or tripoli.

The varnish is composed of one pound either of asphalte, Prussian blue, or fine ivory-black, ten pounds of thick copal varnish, twenty pounds of the linseed oil

prepared as before described by boiling with litharge and lead, and of twenty pounds of spirits of turpentine. The asphalte, Prussian blue, or ivory-black, in the finest possible state of division, is first thoroughly mixed with the oil, and they are then heated together. The varnish first and then the turpentine are each gradually added with constant stirring, until a homogeneous mixture is obtained. This is not ready for immediate use, but must be kept covered in a warm place during two or three weeks, at the end of which time the proper number of coatings are applied to the leather with a fine brush.

The drying-room is maintained at a temperature of from 132° to 167° Fahrenheit; and the greatest care must be taken that it, as well as the apartments in which the skins are covered with the preparation and the varnish, be perfectly tight, clean, and free from particles of floating dust.

The tint of color of polished leather varies with the coloring material which has been added to the varnish; asphalte giving the surface a reddish hue, Prussian blue a greenish-blue metallic tint, and the ivory-black, which is most commonly employed, a pure, brilliant black lustre.

Some manufacturers add to the litharge employed for thickening the oil, red-lead, ceruse, powdered cuttlefish bone, oxides of manganese, and various other metallic oxides and salts.

The success of the whole process depends very much upon the care with which the skins prepared with it have been selected, tanned, and curried. It is particularly necessary that the dubbing should have been applied to them with great uniformity, and only in small quantities, for otherwise the surfaces will soon become tarnished and blotted.

DIDIER'S PROCESS.

In this process, lampblack is heated in a closed vessel, and is mixed with linseed-oil varnish until the mass becomes sufficiently liquid to flow. Two coatings of this mixture are applied to the leather, which is then dried, and coated with a mixture of equal parts of the first liquid and of copal varnish. As soon as this is dry, it is polished with a piece of felt charged with finely powdered pumice-stone, and is then rubbed with a waxed sponge, and wiped with a cloth.

The polish consists of five or six coatings of lampblack and varnish, mixed and brought to the proper consistence by means of a slab and muller, and laid on with a brush. When dry, the surface is again smoothed as before, with the addition of friction with finely pulverized bone-dust, after which two more coatings of the varnish are applied.

White Polished Leather.—White lead is brought to the proper consistence with white oil varnish, and two coats of this are applied to the leather. A quantity of Krem's white is then intimately mixed with water; the water is evaporated, and the powder is incorporated with white copal varnish. Three or four coats of this mixture are then applied, and when dry, the surface is polished in the manner already described.

Red Polished Leather.—The first coating consists of shell-lac ground in oil of turpentine; the second of shell-lac mixed with copal varnish; the last is prepared by dissolving one part of gum copal in two parts of oil of turpentine, and adding to this solution an equal quantity of linseed-oil varnish.

Blue Polished Leather.—A coat of white lead incorpo-

rated with oil varnish is first applied, and then one of Prussian blue and copal varnish. If a lighter blue color is desired, a little Krem's white is added to the mixture.

Yellow Polished Leather.—A mixture of fustic wood, cochineal, alum, and of an alkaline lye is boiled in a copper vessel. This solution is applied by means of a cloth to the leather, and when the latter is dry, a coat of copal varnish is laid on it.

A mixture of yellow-ochre, white lead, and ordinary varnish is then applied, and a second coat of the same mixed with copal varnish is laid on. When the surface is dry, it is polished, and then receives three coats of Turner's yellow in copal varnish.

Polished Leather of the Original Color of Leather.—A coat of a mixture of yellow-ochre, white lead, and oil varnish is applied, and polished when dry. The second coat consists of Turner's yellow mixed with copal varnish.

NOSSITER'S PROCESS.

Mr. Charles Nossiter's patented process consists in removing the grain surface by splitting or buffing, and then making a finish on the surface thus obtained, by means of a glass or other roller, after which the enamelling is proceeded with in the usual manner. This process is particularly applicable to sheep and lamb skins, and produces softer, more flexible, and better-colored leather than that made by enamelling the grain surface of such descriptions of skins.

CHAPTER XLV.

HALVORSON'S PROCESS FOR RENDERING HIDES HARD AND TRANSPARENT.

HALVOR HALVORSON'S process for hardening hides (*Patent Office Report*, 1847, p. 33), consists in subjecting them, in consecutive operations, to the action of alkaline and astringent solutions, and ultimately to that of boiling oil. A horn-like material, applicable to useful purposes in the arts, is the product. The patentee describes his method as follows:—

"I commence my process by taking the raw hide, and submitting it to what the tanners usually term 'sweating,' or putrefaction, sufficient to remove the hair, or instead thereof, I immerse the hide in a solution of lime or alkali proper to remove the hair. I next place it in and submit it to the action of a boiling or hot bath of any powerful astringent and alkaline, or other suitable substance sufficient to remove the animal oil or fatty matter, and to full or mill it up or make it thicker.

"So far as my experience goes, I find sulphuric acid, salts of tartar, and alum, dissolved in water, to answer a good purpose. I keep the hide in the solution (in a state of ebullition), and frequently agitate or stir the liquid, and bend and unbend, or compress and open, or handle or work the hide by tongs, while it is under the influence of the bath, or I remove it from the hot bath,

and, having smeared my hands with oil or grease, in order to protect them from injury from the caustic or other properties of the solution, I lay hold of the hide and squeeze and work it in various ways in order to cause the liquid to penetrate it, and properly act upon it, so as to full or thicken it, and remove the animal fat or oleaginous matter; or, instead of the above mode of proceeding, I make use of any suitable mechanical means, by which the operation of the alkaline and astringent liquid may be facilitated, whether to remove the animal oil, or to full or thicken the hide.

"After thus having fulled it to the desired thickness, or completed the process of removing the extraneous animal oil, I rinse it in warm and clear water, and dry it. At this stage of the process, the hide retains its opacity, and will be found to be very easily affected by atmospheric changes. In damp weather it will absorb moisture, and become more or less soft. In cold or dry weather it will resume its hardness. Consequently, while in this state it is unfit for many purposes. In order to render it semi-transparent, and capable of resisting the influence of ordinary atmospheric changes, or that of a considerable degree of heat, I next immerse it in a cauldron of boiling or hot linseed or drying oil, or any other suitable vegetable or other oil, possessing drying qualities, and keep it therein (while the oil is boiling), until a white or yellowish scale or crisp begins to form on its surface. As soon as this is discoverable, the hide should be removed from the oil. While hot it will be found soft and pliable, and capable of being made, pressed, or moulded into various shapes. When cold, it will be found to have been changed or converted into a substance, resembling, in many respects, horn or tortoise-

shell, and may be bored, turned, or filed, or otherwise wrought like them or ivory.

"I would here remark that, should the hide thus prepared be designed for embossed work, such as figured buttons, combs, or other articles of such nature, it is advisable to remove it from the boiling oil, as soon as it acquires the desired transparency, and softness, and before the white scale, herein before alluded to, makes its appearance.

"After being thus prepared, it may be submitted to pressure in the mould. During the last portion of the process, viz., the boiling in oil, the material may be stained by incorporating with the oil any drying material or materials, that will be proper to produce any desired color. It may be colored also in a manner to resemble tortoise-shell, by such modes as are usually adopted to give to horn such an appearance.

"The oil in ebullition communicates a greater heat to the material, than the astringent alkaline liquid does, in consequence of which it becomes indurated when cold, and susceptible of a high polish.

"The drying oil penetrates the pores of the hide *and takes the place of the animal oil*, previously extracted, and by so doing, not only renders the skin hard like horn, but guards it from the effects of ordinary atmospheric changes, whether of temperature or moisture.

"Where it may not be required to full up or thicken a hide to its greatest extent of capacity, the use of an astringent solution may be dispensed with, it being only necessary, in such cases, to employ the alkaline solution, or some equivalent capable of removing the animal oil and extraneous matters, and afterwards expose the skin or hide to the action of hot or boiling oil, all in the manner above set forth."

CHAPTER XLVI.

CURRYING OF LEATHER.

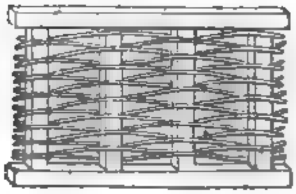
The derivation of the word "Currier" is from the Latin *Coriarius*, which means a workman in leather; the term for skin being *corium*; and both the ancients and the moderns have understood currying as the preparation of tanned skins for the purpose of imparting to them the necessary smoothness, color, lustre, and suppleness.

Curried leather receives different designations, according to the modes of dressing it which are employed, as *tallowed leather*, *waxed* and *oiled leather*, &c.; and it is subjected, in order to receive the required qualities, to the operation of *soaking* or *dipping*, of *treading* or *beating*, of *stretching*, of *oiling*, of *tallowing*, of *dyeing*, and of *polishing*. Before any of these processes are commenced, the tails, foreheads, teats, and parts of the extremities are cut off, and these remnants serve for upper soles, heels, &c. &c.

Dipping.—The first operation of the currier is that of *dipping* the leather, or softening it. For this purpose, the skins are deposited in a tub, or trough, along with water, in which they are allowed to remain until they become sufficiently moist; or else they are sprinkled with water from a brush or broom, which is a much less effectual method. They are then softened by being trod or beaten out upon a strong hurdle (Fig. 143), about a

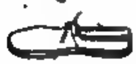
yard square, which is either composed of basket-twigs, or of wooden pegs fixed rectangularly in holes at intervals of about five inches. The leather may either be beaten

Fig. 143.



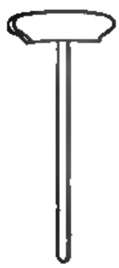
out with the feet, or with an instrument called the *mace*. If the former are employed, the workman should wear large shoes (Fig. 144) made for the purpose, with three thicknesses of sole. Provided with these, he beats and treads out the leather in every direction, by repeated shuffling and stamping movements of his heels, retaining it in place by the left heel, while the right is made to follow the movements of the other in every direction. This is done for a quarter of an hour or longer, until the leather is completely softened and impregnated with moisture.

Fig. 144.



The *mace* (Fig. 145), which is sometimes used, instead of the feet, is made of wood, having a handle eleven and a half feet long (Ure says thirty inches), with a head or mallet four and seven-tenth inches long, and five and a half inches square; upon the two faces of which, parallel to the line of the handle, are four egg-shaped pegs of wood one and a half inches in length, which are finely polished, so as not to tear the moistened leather when it is beaten by them. All skins intended to be tallowed, should not only be beaten by the feet, but with the mace; but, while the use of the latter is very important, care

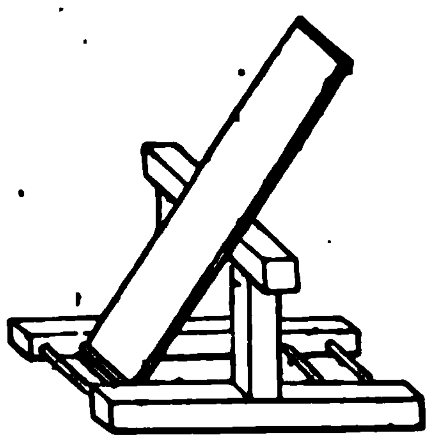
Fig. 145.



should be taken that it be not employed with such force as to be injurious to the leather.

The leather, after having been properly softened by these means, is subjected, upon the *horse*, to the action of the *cleaners*. The *horse* (Fig. 146) consists of a

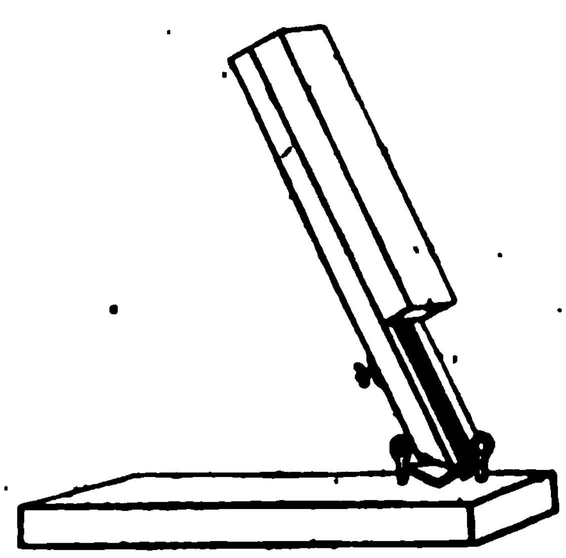
Fig. 146.



strong, firm, flat plank, supported upon a frame by two uprights and a crosspiece, so that it can be made to slope at a greater or less angle. If not sufficiently heavy to be immovable, it may be loaded with stones, or weights, placed upon the frame.

A more convenient beam is that patented in this county, by N. Sargent, and shown by Fig. 147. The up-

Fig. 147.



right is fitted with adjusting screws, by which it may be elevated or lowered to any desired height, as may suit the comfort and convenience of the workman.

Formerly, and in some places at the present day, three

instruments have been and are used for the cleaning and paring of leather; the sharp-edged cleaner, the blunt cleaner, and the head-knife; but the latter alone is used now in Paris for this first working.

This knife (Fig. 148), which is called in French *couteau à revers*, on account of the form of its edge, which is very much turned over, is from twelve to fourteen inches long, and from four and a half to five and a half inches broad; and has two handles, one in the direction of the blade, and the other perpendicular to it, for the purpose of guiding the edge more correctly over the surface of the skin.

Fig. 148.

The round-knife (*lunette*), is a circular knife from ten to twelve inches in diameter, with a round, four or five inch hole in the centre, for introducing the hands. It is concave, of the form of a spherical zone; the concave part being that which is applied to the skin, and having an edge a little turned over on the side opposite to the skin, so as to prevent it from entering too far into the leather. Besides these, the sharp-edged and blunt-edged *cleaners*, Fig. 149, are sometimes used. The latter is usually made of an old knife, and is provided with two handles; the former may be made of an old sabre.

Fig. 149.

Curriers are recommended to dispense with these cleaners, to use the head and round knife for shaving and paring the skins upon the horse, and to confine themselves to the employment of the stretching-iron for smoothing and scraping the leather, for filling up its weak parts, removing the creases, and the filamentous particles which project from its surface.

Shaving.—The second operation of the currier after dipping and softening the skins, is to pare or shave them

with the head-knife, for the purpose of securing uniformity of thickness and regularity of surfaces. When, however, the leather presents many weak and thin parts, this operation may sometimes be dispensed with or postponed, until these have been filled up by the action of the stretching-iron. While preferences are given in different places to other modes of working some kinds of leather, all kinds indifferently are shaved, by Parisian curriers, with the head-knife and round-knife: they use the *French horse*, however, for paring off the borders of the skins, with the latter instrument, and the *English horse*, for the other parts of the operation, which are conducted with the head-knife.

For rendering the surface of leather smooth and compact with the stretching-knife, the table has been generally substituted for the horse.

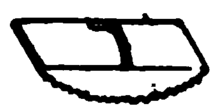
Fig. 150.

Pommelling.—All leather should be submitted to the action of the pommel, so called, because it clothes the hand and performs its functions. This instrument is of rectangular shape and of different sizes, but is usually about thirteen inches long, and five inches broad, and is made of dogwood. The upper surface is flat, and is provided with a wide leather strap nailed to the sides, which is intended for confining the hand of the workman. The lower surface is rounded and furrowed over with transverse straight ridges and grooves. These grooves are

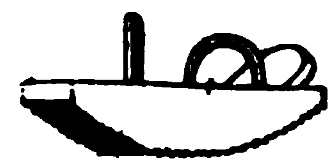
sharp-edged isosceles triangles in section, and vary in fineness according to the size of the pommel, the largest being from seven hundredths to two-tenths of an inch deep, and two or three-tenths of an inch wide. (Figs. 151 and 152.)

Figs. 151.

152.



153.



A large kind of pommel, called in French the *marguerite* (Fig. 153), is now employed for nearly all the operations in which the ordinary one was formerly used. It is from fifteen to nineteen inches long, five inches broad, and of a thickness in the middle of from three and a half to four and a half inches, and at the end, of from one and nine-tenths to two and two-tenths inches. As it is much more heavy and difficult to manage than the pommel, a peg or handle is placed at one end for the workman to grasp, while his arm is passed under a large strap, and his elbow rests upon a cushion at the other end. The grooves are larger and further apart than those of pommels, and differ in size with that of the *marguerite*, which may be made for particular purposes, larger or smaller than the one which has been described.

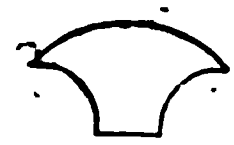
These instruments are the ones which are the best adapted for the purpose of giving flexibility and a granular appearance to the leather. The skin is first folded with its grain side in contact, then stretched out upon a table, and rubbed strongly with the pommel, or *marguerite*, each quarter successively being made to slide under the instrument, over the leather below it, first towards the centre, and then back to its original position. This mode of working leather, makes it extremely flexible. To give the proper grain, the skin is then stretched out

upon the flesh side, and pommelled from head to tail and crosswise.

Stretching.—This operation is performed with the *stretching-iron* (Figs. 154 and 155), which is a flat piece

Fig. 154.

Fig. 155.



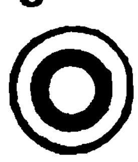
of iron or copper, a fourth of an inch thick at top, and thinning off at the bottom into a blunt edge, shaped like an arc of a very large circle. It is about six inches long and four inches high, and is provided with a handle ten inches in length and five in height. An iron or steel instrument is generally employed, as being less likely to wear out than a copper one; but the latter is preferred by many, since the leather is sometimes blackened and spotted by the iron. One made of steel is less objectionable on this account. Stretchers of other forms and dimensions than the one described above are sometimes used, but they vary very little from each other in construction. Those formerly used were without handles, and had a copper rim to protect the hands of the workman.

Fig. 156.

The skin being placed upon the table, the workman grasps the stretching iron in both hands (central figure,

Fig. 156), and holding it nearly perpendicular upon the leather, forcibly scrapes the thick places so as to render them of uniform thickness with the rest, to remove particles of flesh or projecting filaments, and to fill up the thin and weak spots. The leather is rendered smoother, softer, more compact, and equal throughout by this operation, to which all kinds of skins should be subjected; and when thus treated, there is no absolute need of the application to them of oil or tallow.

Fig. 157.



Working with the Round-Knife.—Leather is subjected to the action of the *round-knife* (Fig. 157), an instrument which has already been described, after its edges have been sloped off with the head-knife, an operation which is performed upon the horse by shaving off a layer of two inches in breadth all around the borders of the skin. They are then worked with the round-knife upon the *dresser*, which is a cylindrical wooden bar fastened at a height of five feet, three inches from the ground, by its two ends, to two buttresses projecting from the wall.

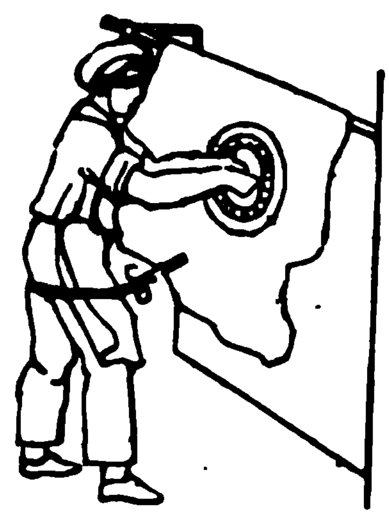
A thick cord is stretched along the upper surface of this bar. The end being separated from the dresser, the breadth of the skin is folded over it, the grain being within, and the skin is turned over and stretched around the beam, its end being firmly held between the bar and the cord, which is still more tightly pressed down by the leather which envelops it. (Fig. 158, a skin stretched upon the dresser.)

Fig. 158.

Fig. 159.

The skin being thus stretched, the workman seizes the lower part of it, and confines it in place by a pair of pincers (Fig. 159), attached to his girdle, and grasping the round-knife in both hands, works the leather with it from above downwards, removing the fleshy, thick, or projecting parts. This paring (Fig. 160), which

Fig. 160.



is an operation requiring the utmost care, is generally done from tail to head, and sometimes across the grain.

The round-knife must be occasionally sharpened upon an oiled stone (Fig. 161) to keep it in good condition, and the edge must be kept turned over by a steel, so as to prevent it from entering too far into the leather.

Fig. 161.

According to Dessables, this operation is at the present day used only or chiefly for goat-skins, all the other kinds being pared with the head-knife. A workman can pare an ordinary skin in an hour upon the dresser, and six or eight dozen goat-skins in a day.

Before being subjected to the operations of the currier, hides are frequently cut in half, and are still more often made into an almost square form by cutting off the head and belly parts, leaving the tail still attached to them. These square hides contain all the best and strongest parts of the leather; the head and belly por-

tions being the weakest, and being only used by shoemakers for the finest or upper soles.

STRETCHED LEATHER.

The skins of cows and of young oxen made into crop-leather are the only ones which are fit for *stretchers*, and when thus prepared do not require the application of oil or tallow. All curriers do not pursue the same method, some preparing crop-leather, or that which has been tanned in bags by the Danish plan.

After the leather has been dried, it is moistened, fleshed on the horse, moistened a second time, scraped with the stretcher, and, when thoroughly dry, is well-slicked with the glass-polisher, so as to smooth the grain.

Before stretching a cow-skin, the head was formerly removed, as being too thick to be properly smoothed; but it is at the present day usually left on, as it forms a considerable addition to the weight of the leather. The skins are first cut in half from head to tail, the whole skin being too large to be properly worked, and are then deposited in tubs full of water, in which they are allowed to remain for twelve hours. When thoroughly wet, they are taken out, are spread on the table and worked from tail to head with the stretching-iron, or, if it is preferred, they can be lightly pared on the horse. Either of these operations being completed, the skins are well pummelled and worked with the *marguerite* from tail to head and cross-wise, and then dried. When they have been stretched, and deprived of the greater part of their moisture, they are dampened slightly with a wet cloth upon the hair side, and are again scraped with the stretching-iron. The hair side is again well moistened with the wet cloth; the skins are then dried, placed under the

press, and, after three or four hours' exposure to it, hung up to dry. When nearly dry, they are piled up in a dry and clean place, and covered with weighted planks, when the operation is completed.

Leather, prepared in this way, is not blackened, and does not require, as has been before stated, the application of oil or grease. It is used by saddlers and harness-makers, and by shoemakers for the soles of pumps, and the upper soles of large shoes.

SLEEKED LEATHER.

Sleeked leather, which is intended chiefly for saddlers and harness-makers' use, should be made of strong hides; thick cow-skins and ox-hides being generally preferred for the purpose.

The hides, as they come from the tan-yards, are cut in two, are deprived of the head parts, soaked in the tub and trod out, care being taken not to allow them to become too thoroughly saturated with water. They are then lightly fleshed with the head-knife, pommelled, and half dried by exposure to the air. In this state, they are again trodden out, hung up to dry, and trodden out for the third time; pommelled on both sides, and at last hung up until thoroughly dried. In order to make known the weight of each skin, they are marked with Roman characters designating it.

Before being tallowed, the flesh sides are rapidly *flamed* by being drawn over a blaze of fire from lighted straw, so as to make them more penetrable by the grease. The kind of fatty matter is left to the choice of the operator, but mutton-suet is undoubtedly the best, and gives a finer lustre to the leather than any other, but is more expensive. The Parisian curriers chiefly make use of

suet *rendered* from kitchen drippings. Six and a half pounds of suet are required for a hide of ordinary size.

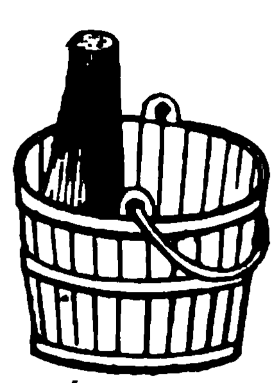
When the grease is melted and heated to the proper point, which the workman himself must decide upon, the skin is stretched upon the table, and the operation commenced by spreading the tallow over the surface with a tallowing cloth or mop (Fig. 162), which is made of the feathery or fleecy parts of blanket-stuff. It is from fifteen to nineteen inches long; a handle being made for it by binding, or tying up from eleven to thirteen inches of its length, leaving a tuft long enough to answer the purposes of a mop.

Fig. 162.

The grease is first applied upon the flesh side, as being the most absorbing surface, and then upon the grain; and more of it is rubbed over the groins, edges, and thin parts, than over the rest, so as to increase their strength and body. A good workman can tallow a hide in about five minutes.

When greased, the skins are folded square, the hair side in, and are then soaked in a tub during eight or ten hours; after which they are trod out in water and beaten with the mace until deprived of most of their watery contents. They are then again moistened with a wet broom (Fig. 163), or soaked for a time, and once more beaten in

Fig. 163.



every direction. The leather is then pommelled with the *marguerite* upon the flesh; and the hair side is pommelled from tail to head, and crosswise, until the grain

is well smoothed, when the skin is placed upon the table with the hair side up, and the surface is smoothed by the forcible use of the stretching-iron.

The leather is now blackened while still upon the table, being moistened before this operation, if it has become too dry, since a certain degree of humidity is necessary to enable it to receive the color. For this purpose, a mop of wool, or brush of horse-hair, is dipped in the composition prepared for the purpose, and the hair side is thoroughly rubbed with it in every direction (Fig. 164).

Fig. 164.

After the first black, the leather is three-quarters dried by exposure to the air, and the stretching-iron is again passed over the surface, great care being taken to avoid scratching it; uniformity and smoothness of surface being secured by moving the instrument constantly and regularly in one direction, away from the position of the workman. The leather is made to appear thicker and uniform by paring off the edges with a hooked knife (Fig. 165).

Fig. 165.

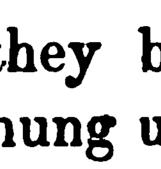
Two applications of black are generally required for sleeked leather, and when any parts of the surface remain of a red color, even a third may be requisite. The second coat is applied in the same man-

ner as the first; the leather is again partially dried, and the surface slicked, until the marks of the stretching-iron have been entirely removed.

When the leather is of a fine black color and perfectly dry, it is exposed to the action of a press for a time not longer than two weeks, during which it is increased in density and firmness, the excess of tallow being forced out from it. If perfectly dry when placed in the press, it retains the original appearance of its surface, but if still somewhat moist, it is usually found covered with mould when taken out.

In order to give the last dressing to these skins, the hair side is well wiped, so as to remove any portions of grease remaining upon it, or the mould which has formed on the surface. A polish is given with sour beer or barberry juice, and the surface is slicked with a very smooth stretching-iron or a lump of smooth glass (Fig. 166).

Fig. 166.



If any spots of grease or defects of surface remain, the parts which are thus deficient are gently rubbed with a cloth dipped in the polishing liquid, until they become perfectly bright. The leather is finally hung up to dry in a place not exposed to the direct rays of the sun.

For blacking leather, the Parisian curriers usually employ hatters' black, which is composed of logwood, nutgalls, gum, and copperas.

The best dye is made in the following manner: Scraps of old rusted iron are deposited in a deep vessel and covered with sour beer, which is allowed to act upon them for three months. A red liquid is thus formed, which is a solution of acetate of iron, and which blackens the leather better, and with more rapidity, than the solution of copperas.

Another liquid may be made use of, which is less expensive and requires less time in the preparation. Sour beer is mixed with yeast from barley, and, after twenty-four hours, is added to a solution made by boiling copperas in vinegar, care being taken first to remove all the yeast from the surface. A mixture of solutions of sulphate and of acetate of iron is thus formed.

TALLOWED SKINS, OR GRAINED LEATHER.

Tallowed or grained cow-skins are those the grain of which has been brought out, instead of being smoothed down and polished, as in sleeked leather. These skins are softer and more flexible than the latter, and are less liable to be penetrated by moisture; trunk-makers, saddlers, and harness-makers make use of them for applications of leather which require these qualities, and the largest of them for carriage-tops.

For the preparation of this kind of leather, the finest cow-skins are selected, and these are not cut in half, but are dressed entire. The skins are first trodden out with the feet until the irregularities of surface are made to disappear, and are then pared with the head-knife, in order to secure perfect uniformity of surface. The edge of this knife should be perfectly straight and even, so that the leather may not be streaked or scratched by its use. After this operation, the skin is half dried, and then worked again with the feet while in that state, and trodden out so as to be even and free from all depressions of surface.

The leather is now again exposed to dry, but not to complete dessication; it is beaten once more, and then rolled up first upon the flesh, and afterwards upon the hair side, by which the creases are made to disappear.

If it has become too hard for this operation, it is moistened by sprinkling with water from a brush. Finally, it is pommelled with the cork from tail to head.

The leather is now dried, not thoroughly, but sufficiently to allow merely an insensible amount of moisture to remain in it, and is then tallowed in the manner already described, after having been *flamed* on both sides. Before this process, some tanners are in the habit of sprinkling water from a brush over both surfaces, so as to increase the pliability of the leather; but the practice is improper, inasmuch as the excess of water must prevent the grease from thoroughly penetrating the substance. From 3½ to 4½ lbs. of tallow are usually required for a cow-skin, and rather more than 1 lb. for a thick calf-skin.

After the skins have been tallowed, they are rolled, and left folded, up with the hair side within, for some hours or even days. They are then folded square, and placed to soak in a tubfull of water during eight or ten hours, and are worked while in the water, until the excess of grease which has remained upon their surfaces, is washed or floated off. The soaking has been sufficient when these latter assume a uniformly white appearance.

In order to bring out the grain, the leather is now well worked with the *marguerite*, and the hair side is pommelled, after which both sides are cleaned with a horsehair brush, and the creases are taken out from the parts which have been folded, by the use of a smooth stretching-iron (Fig. 167), the operation being conducted upon a clean table. The skins are then sprinkled with water, cleaned again, doubled up and hung out to dry, retouched with the stretching-iron, and finally moistened slightly before the application of the black.

Fig. 167.

The blacking composition is prepared and applied in the same manner as in the case of sleeked leather. The skins are then half dried, blacked a second time, smoothed with the stretching-iron, wiped, folded up with the hair side within, and piled upon each other in that condition. They are then taken down, blacked a third time, smoothed and wiped as before, and then perfectly dried. They then receive a coat of sour beer, and the four quarters are worked with the *marguerite*; the hair side is pommelled across, and rubbed with a piece of old blanket or flannel, and a second coating of sour beer is applied.

When smoothed and cleaned by these means, the lustre is brought out by the use of the stretching-iron, by wiping with the old flannel, and by rubbing the surface lightly with a smooth, compact piece of woollen stuff dipped in the barberry juice. The surface is then pommelled, first obliquely, afterwards across the breadth of the skin, and finally from tail to head, so as to round off the grain as much as possible.

Finally, to give the last dressing to the leather, it is heated again with sour beer, exposed anew to the air until dry, and once more rubbed with a cloth dipped in barberry-bush juice.

A workman is usually occupied eleven or twelve days in preparing thus completely a dozen black skins.

Tallowed hides are made use of by trunk-makers, harness-makers, and saddlers, and serve for saddle-flaps and carriage-covers; the largest and finest of them being reserved for carriage-tops. One of these skins, without natural defect, and perfectly prepared in every part, is always looked upon by the currier as the triumph of his art.

Different materials may be used for the purpose of giving a lustre to skins of this kind, as sumach, hot

ooze and water, sour wine, or weak brandy. By dissolving gum Arabic and sugar in sour beer, an admirable liquid for the purpose may be obtained. Many other means are employed for giving a gloss to the surface, some consisting of sugar or molasses dissolved in beer, others of infusions of cassia in beer and vinegar, separately prepared, and then mixed together; cherries, gooseberries, or common gum can be equally well used for the purpose. All of these substances are less expensive than the barberry, and quite as efficacious.

WATER-LEATHER.

This name applies to the larger and finer neat-skins, which are sent direct from the tannery to the currier, who does nothing but pare and expose them to the air before sending them, still in the wet state, to the carriage-maker. The latter does not receive these skins until about to make use of them. He then places them upon the carriage, fixes them in position, and without making other changes, *blackens* and varnishes them. The carriage-tops made in this way are called *imperials*, or *capotes*.

OIL-LEATHER.

Two kinds of oil-leather are manufactured, the one black, intended for the harness-maker; and the other uncolored, for the use of shoemakers. This kind of leather is exceedingly durable, and curriers always select, for the preparation of it, the most entire and well-tanned skins they can find.

Whether skins are intended to be *blackened* or not, they should in either case be dipped, but after this part

of the operation has been gone through with, they should be kept separate, as the future processes are essentially different for the two kinds.

Those skins intended to be blackened on the hair-side, should alone be beaten. The operation is then finished with the round or head knife. At first, they are treated like tallowed hides; that is, they are dipped, and then beaten, if the intention be to trim them with the round-knife, and they are fleshed if this is not the case. They are then worked with water in a cask (Fig. 168), with a

Fig. 168.

Fig. 169.

long pestle (Fig. 169). A number can be operated upon at a time; and as the object is to make them pliable and soft, they are often treated in this way seven or eight times, being each time re-dipped, and worked in the same manner.

After the skins have thus been well worked, the flesh side is stretched upon marble tables, and the hair side worked with the stone, and to extend them thoroughly, the stretching-iron is well laid on, by which process all the water is pressed out. The stone used for the purpose is a piece of good grit stone, set in a handle in the same manner as the stretching-iron. The skins having in this way been freed from the greater portion of their

watery contents, are then exposed, for the purpose of drying, either in the open air or within the building; one hour's exposure usually sufficing in summer, while in winter many more are required. After being sufficiently dried, they may at once be held in readiness for the application of the oil.

Fish-oil alone is sometimes used for this purpose, but the experience of nearly a century has proved that train-oil scouring is of all fatty substances the best for the purpose. It is a mixture of fish-oil and of potash, which has already served to clean skins converted into chamois leather; and many advantages are obtained by using it. It has more density than ordinary fish-oil, and is more completely absorbed by the leather. Its saponaceous quality contributes to give softness and tenacity, and less of it is required than of oil. Its quality should, however, be well ascertained before using it, as if it has not been well boiled, and still contains water, it will not possess the proper penetrating power. Train-oil scouring can be procured in all places where chamoïs leather is manufactured, but that used by French and Parisian curriers is almost entirely supplied by Grenoble, Strasburg, and Niort.

According to Delalande, neat's-foot oil adds to the good qualities of leather. It is only necessary to boil the feet, &c., thoroughly in water, to draw off the liquor, and place it in a kettle with water heated to the boiling point. This is boiled for nearly twenty-four hours. The pure oil which rises to the top is drawn off, and placed in another kettle containing water at about 125° F. After allowing it to remain at this temperature for twenty-four hours more, it is cooled, and three different layers of oil which rise to the surface, are drawn off separately by as many spigots in the side of the vessel. The

heaviest of these is said by Delalande to render leather perfectly impervious to water.

Whatever be the quality of the scouring, it is impossible to employ it alone, but it must invariably be mixed with fish oil. The proportions of this mixture it is impossible to give accurately, as they depend upon different circumstances, some of which have reference to the temperature of the air, the kind of leather employed, and the dressing intended to be given to it, and others to the consistence of the scouring itself, and finally to the peculiar mode of operating pursued by the currier. Thus in summer, but a small quantity of oil is added to make the mixture, while in winter a much larger proportion is required. Poor and thin hides, which have been left too long a time in the lime-pits, require but little oil and a good deal of oil scouring, because they cannot retain much of the oleaginous matter, and would absorb too quickly that which has the greatest penetrating power. When the skins are exposed to the action of the mixture, they imbibe upon the first application much more than upon the second. The denser the oil scouring, the more oil is required; but the quantity of the latter, which is often made to amount to one-fourth of the mixture, should never exceed one-half of it.

Experience has shown that for a neat-skin weighing 16 lbs., 4 lbs. of the oily material are required, and that 10 lbs. are expended upon a dozen calf-skins weighing 30 lbs., thus giving the proportions of about one-fourth of their weight of oil for the former, and one-third for the latter.

The skins which are intended to undergo the oiling process should contain just enough water to enable them to yield a small quantity upon being wrung out. If

they be dry or only slightly moist, they will absorb the oil too rapidly, while it is essential for the perfection of the process that their substance be gradually penetrated by it. When, on the contrary, they are still quite wet, they take it up slowly, in proportion as they lose their water. The operator should, therefore, before oiling them, carefully ascertain that they are just wet enough for the purpose, and should moisten again those parts of them which have become too dry. The other extreme should, however, be as carefully guarded against; as, when the hides are very wet, too much of the oil scouring is consumed in forming a soapy compound with the water.

After the skins have received their coating of oil upon both sides, and the workman has uniformly distributed it over the surfaces with the hand or the tallowing-cloth, he hangs them up by the hind quarters, and allows them to remain in the air long enough to absorb their contents of oil, taking care not to let them be exposed to the extreme heat of the sun or to a great draught of air, as if they be dried too rapidly, the oil will not penetrate them in the gradual manner necessary for the perfection of the process. Ten or twelve hours of exposure are usually sufficient in summer, while in winter, two or three days are often required.

The bellies of neat sides require less oil than the other parts, while, on the contrary, those of calf-skins absorb more.

The oil scouring should never be warmed in winter, as is often done.

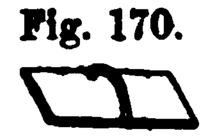
No uniform method of oiling skins is pursued. In some establishments, the oil alone is applied to the hair side, while a mixture of oil and scouring is placed upon the flesh side; and in others, again, the mixture is applied to

both surfaces. Some curriers again, make use of no oil whatever; but apply the oil scouring to both sides, taking care only to stuff the flesh side most plentifully with it. These different modes of proceeding seem to succeed almost equally well, and we refrain from condemning any one of them; but will observe that in every instance care must be taken not to give the hair side too large a quantity of scouring, or it will be very difficult to give the requisite gloss to that surface. It is also necessary to add, that those skins intended for saddlers' use, do not require one-third as much oil stuffing as is needed for shoemakers' leather.

After the skins have become sufficiently dry, they are to be fulled, and recharged with some of the fish-oil and a lesser quantity of oil scouring, again fulled, and finally, the hair side is to be thoroughly scoured by a brush dipped in a solution of potash. The skins are immediately after this blackened, care being taken to keep the borders clean. The blacking, which has already been described, is used and always applied in the same manner.

After the first blacking, the skins are pommelled crosswise, a second coating of black is applied, and they are exposed to the air until completely dry. When dry, they are beaten, pommelled, and trimmed, passed over with the head or the round knife, then rubbed with the cork, and the process is completed by lightly oiling the hair side. (See a cork pommel, at Fig 170.)

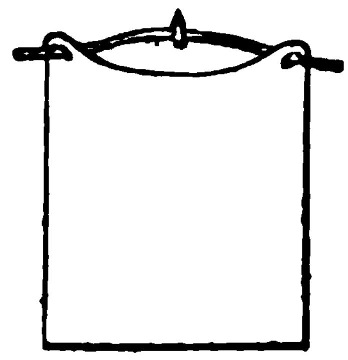
Fig. 170.



These last operations, again, are differently performed by different curriers. Some, after the first coating of black, do not full the skins, but pass the stretching-iron over them upon the table. They then moisten the hair side, pass over it the solution of potassa, and give the second coat of black. To

smooth them and to impart grain, they pommel them from tail to head, and also across the grain. Either of these methods may be pursued, but the last is preferable. As harness-makers need for their purposes very strong skins, square oiled hides or *croupons* are prepared especially for them, or skins, the heads and belly pieces (*têtes et ventres*) of which have been cut off, by which each skin is reduced to one metre forty-six in length, and one metre and some centimetres in breadth. (See a *croupon*, Fig. 171.)

Fig. 171.



Uncolored leather, which remains to be noticed, will be considered in a separate article.

WAXED LEATHER.

Waxed skins are those which have been rubbed over with wax, melted and maintained at a heat sufficiently great to allow it to penetrate the leather. As this mode of treating them is costly, very few of them are now prepared, particularly as the saddlers and harness-makers, for whose use they have generally been furnished, no longer buy them. Nowadays the name is applied almost entirely to the tallow hides, which originally had great consistency, as they were prepared with great care. Some manufacturers, to give great firmness to certain skins, add to the tallow from one-eighth to one-fourth of wax. In general, smooth sleeked skins, with this

property of great firmness, are used and sold by carriage-makers as waxed skins, and are held in great esteem for their beauty and durability.

ENGLISH HIDES.

Those smooth and well-grained skins are so called, which are made pliable by means of tallow, and retain their reddish or yellowish color. For this purpose well-tanned skins of the best quality, which are white on the hair side, perfectly clean, and free from greenness are selected. Those from Louviers and Nemours are preferred. These skins are dipped in the same manner as the sleeked leather, and the workman should handle them with the utmost care, as the least spot renders them unfit for use. They are then worked and pared, after having been dipped and exposed to the air, and are well pommelled on both sides to efface the wrinkles, and dried thoroughly before being tallowed.

When this is done, the hair side is wet with a clean cloth dipped in pure water, to prevent the tallow from entering the weak parts. The tallow applied to the flesh side should not be as warm as that used for the tallow hides and sleeked leather; and as one of the principal objects of the process is to make them retain their natural color, only a small quantity should be applied, so that it shall not penetrate fully to the hair side. After being tallowed, the hides should be soaked for a half hour in clean water. Dessables thus describes the process.

"When the skins have been soaked, they should be worked in water, stretched, and a light and uniform coating of fish-oil, or what is better, linseed-oil, spread over the hair side with a piece of wool or cloth. They

should then be allowed to dry, and the process finished in the same way as with sleeked leather, except that a stretching-tool of copper is used instead of one of iron, which might spot or soil the surface. After the skin is thoroughly dry, a color made with French berries is applied on the hair side. Six hides may be colored with two *grammes* of berries, which quantity is to be placed in a *litre* of beer. The color should be laid on with the utmost care, so as to secure a uniform coating, and also as briskly as possible, otherwise, the skin will be spotted or discolored.

"After coloring the skins, they are to be exposed to dry in the open air, avoiding the direct heat of the sun, which would cause the oily matter to penetrate through to the hair side, and to discolor its surface. The barberry is not required, but it is sufficient to rub the skin until it becomes dry with a small cloth or piece of linen, by which the surface is rendered sufficiently smooth and polished. Some curriers do not even color skins of this kind, but content themselves with smoothing them.

"A method still different from this is sometimes followed. When the skins meant to be yellowed have been properly prepared, they are pommelled to make the inequalities of the surface disappear, and fulled in a cask containing clean water (Fig. 172). They are then placed

Fig. 172.

upon a marble table with the flesh side uppermost, again replaced upon the stone with the hair side up for stoning, and drawn out with the stretching-iron. This should be pressed down very firmly, for the purpose of stretching the leather, and of making it compact and firm. They are then dried a little, and again and again treated with the stretcher of copper, care being taken to dry them well after each dressing, with a clean woollen cloth. After this linseed-oil is applied to the hair side, and a composition of equal parts of fish-oil, oil scouring, and fine white tallow, melted together and passed through a hair-cloth sieve, is used for the flesh side.

In order that the shoulders and legs should have a uniform color with the body, it is proper to apply a less amount of the liquid to them. After this oiling, the skins are dried by hanging them upon a rod, with its ends passed through the tail and one of the legs. When dry, they are placed anew upon a table of marble; the flesh side is forcibly stretched out with a warm stretching-iron, for the purpose of cleaning them and making them compact. The hair side is then placed upwards, moistened with a little clean water, treated with the copper stretcher, dried carefully with a clean rag, and passed over with the stretcher once more before the final drying. Sometimes a color made with a little Brazil wood, yellow berries, and glue, heated together, is used. This color is passed rapidly and lightly over the hair side, and the leather is then stretched and exposed to the air until perfectly dry, and is finally *slicked* with a piece of glass, attached to a handle like that of a stretching-iron. Skins prepared is this way are higher priced than tallowed leather, and are chiefly used by harness-makers.

WHITE LEATHER.

This kind of leather is used chiefly by shoemakers for the uppers of large shoes, the hair side being placed within. The skins are not worked up whole, but are made into square hides by cutting off the head and belly-pieces, which, being too thin for the purposes for which the leather is employed, are used for the first or upper soles.

The skins are first well dipped, and then scraped carefully with the head-knife without being shaved. They are then treated on both sides with the oil and train-oil scourings, dried, beaten out with the feet, trimmed on the borders, pressed and pommelled to efface the creases. The preparation is completed by pommelling with the cork, so as to smooth the flesh, and grain the hair side.

This leather should be well stuffed, each skin absorbing usually three and a quarter pounds of oil and train-oil scourings. Some curriers confine themselves to pommelling these skins on both sides, and then drying them, asserting that they are finer for not being beaten.

COMMON RUSSET.

Leather of this quality is prepared in the same manner as blackened leather, except that it is allowed to absorb grease to saturation, so as to increase, as much as possible, its strength and pliability. For this purpose, after the skins have been tallowed and half dried in the air, they are imbued with train-oil scourings on both sides, about one pound ten ounces being used for each skin. This leather preserves nearly its original color, and is used chiefly for pump-valves, mail-bags, bellows, and for other purposes not requiring much beauty of surface.

CHAPTER XLVII.

CURRYING OF CALF-SKINS.

Sometimes calf-skins are prepared almost in the same manner as neats-leather, the thickest and largest of them being occasionally used for the same purposes as square hides; but the latter being commonly employed in the manufacture of soles, the calf-skin leather being only used for uppers, and being consequently required to possess more pliability and softness, must be treated by processes differing from those to which thick leather is subjected.

OILED CALF-SKINS.

As soon as the skins are taken from the pits, they are dried immediately, scraped and trodden out under the feet, and then oiled on both sides. Some curriers make use of warm oil in winter. The mixture of equal parts of oil and train-oil scouring is generally used as in the oiling of cow-skins; but if the train-oil scouring be very clear, it can be employed alone. From eleven to thirteen pounds of the oil are commonly required for a dozen calf-skins weighing from thirty-three to forty pounds, though experience alone will enable the workman to judge of the amount which the skins are capable of absorbing without injury. The application of an

excess of fatty matter should generally be avoided, as it tends to make the leather too soft and flabby. Skins, which have been exposed too long in the lime-vats, do not take up, or retain as much oil as those which have not been thus injured. After having been oiled, the skins are dried and generally are dressed and softened by beating with the feet, and bringing out the grain in the usual manner. The mode of preparation, however, varies with the uses for which the skins are intended; those which are to be waxed, or converted into grained or stamped leather, not being worked with the feet.

In order to cleanse and soften the leather, and to prepare the hair side for the reception of the black, a brush is dipped in a solution of potash made by dissolving rather more than a pound of potash in a bucket-full of water, and is passed over the surface. A stronger solution might injure the leather, but one of the strength indicated is sufficient to combine with the excess of oil upon the surface, converting it into soap, and enabling the coating of black to adhere more readily to the surface. This operation completed, the blacking liquid, which has already been spoken of, is applied at once, care being taken not to lay on a large enough quantity to penetrate below the surface of the leather. The skins are then pommelled from head to tail with a medium-sized pommel, used with four parts of oil and one of train-oil scouring, in order to smooth down the long ridges which traverse the leather in different directions. A second coat of black is then applied, and, if necessary, the leather is again charged with the same oily mixture, after which it is thoroughly dried by exposure to air. It is then trodden out, pommelled on both sides, pared down on the borders with the head-knife, and scraped with the round-knife. To complete the preparation, it

is pommelled with the cork, and lightly rubbed over upon the grain with fish-oil, in order to deepen the color, the appearance of which the previous working may have injured.

Another method is sometimes followed. The skins, when dry, after oiling, are soaked in a tub until sufficiently damp, without being thoroughly penetrated by moisture, and are then pommelled lengthwise and blacked. After this, they are pommelled crosswise, blacked a second time, charged with the oily mixture mentioned above, dried thoroughly, and finally worked with the pommel from head to tail, and oiled as before.

TALLOWED CALF-SKINS.

A large proportion of the calf-skins used are oiled; but those which are tallowed are much less liable to be penetrated by moisture. To prepare them, the dry skins are sprinkled with water from a brush and are scraped with a dull knife, or with the stretching-iron, unless it is desirable to diminish their thickness by paring. The head is then pared down with the head-knife as far as the junction of the neck, and the body is lightly fleshed with the same instrument, the surface being well moistened to prevent the knife from entering too deeply. The skins are then dried and pommelled upon the flesh with a large pommel, and upon the grain with the cork, instead of using pumice-stone, which was formerly employed. They are then tallowed in the same manner as cow-skins, dried, worked under water, pommelled, and blackened twice; after which, they are pommelled again, and polished or rubbed upon the grain side with clear oil. From thirteen to sixteen and a half pounds of tallow are

required for a dozen calf-skins weighing from forty-two to forty-four pounds.

These skins are used by harness-makers and saddlers for the covers of horse-collars and other purposes. They are also employed in the manufacture of thick shoes, and to cover trunks, chairs, and tables.

ENGLISH CALF-SKINS.

The best kinds of skins are selected for the preparation of this kind of leather, and the processes employed in its manufacture are similar to those by which the cow-skins, intended for corresponding purposes, are prepared. The skins are tallowed upon the flesh side, but only a small quantity of grease is used, so that the leather may not be penetrated by it, and this and the succeeding manipulations must be conducted with the greatest skill and care, in order to avoid injuring or soiling the surfaces.

The thicker skins are curried white for the uppers of thick shoes, while the thinner ones are used for thin soles. Formerly, the white leather of this sort was used for heel-rands. The skins are slightly moistened, pommelled in every direction, and after being oiled and thoroughly cleaned, should be shaved down on the borders, pared from tail to head, worked two together, with their flesh sides in contact, until soft, and then pommelled, scraped with the round-knife, and passed over with the cork. The greatest care should be taken in all these operations, to avoid scraping or scratching the surfaces, which are much more liable to receive injury than those of neats-leather. If any of the skins are found to have been taken from stillborn calves, injury to them is avoided

by passing them through tan-liquor and exposing them again for a time in the pits.

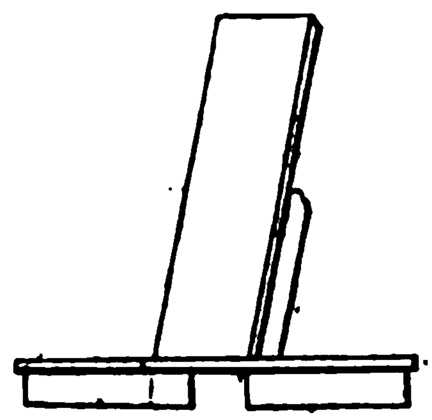
WAXED SKINS.

This kind of leather has only been prepared during the last forty years, yet so great a degree of perfection has been attained in its manufacture that it is now very generally used for the legs of boots, and for men's and women's shoes.

The heads and ends of the extremities of skins about to be converted into it, are first cut off, and the leather is then moistened, fleshed, and pared so as to be perfectly uniform throughout; being reduced to the thickness suitable for the purposes for which it is required. It is then deposited in a tub-full of water, and is beaten with a rammer or pestle, and then scraped upon a marble or wooden table with the *slate*, first upon the flesh, and afterwards upon the hair side. After this proceeding, it is washed, scraped with the stretching-iron, and partially dried. When the proper degree of desiccation has been arrived at, it is worked again with the slate and stretching-iron, only upon the hair side, and is then oiled on both sides; a mixture of oil and of train-oil scouring being applied to the flesh, and clear oil, or a combination of oil and tallow, made thick enough not to spread beyond the place upon which it is deposited, upon the hair side. This latter mixture is a very suitable application in summer, when oil alone is almost too fluid. As soon as the leather has imbibed a sufficient quantity of oily matter, it is dried and thoroughly cleaned and smoothed upon marble, or a smooth table, by the use of a hot stretching-iron. It is then pommelled from head to tail, and from

the quarters; is placed on the horse (Fig. 173), and cleaned with the head-knife, and rubbed across with the cork.

Fig. 173.



After these preliminary operations, the leather is ready to receive the composition, which must be applied with the greatest care and exactness, so as to secure perfect uniformity of surface and of color, either extreme of applying too much or too little being avoided, so that on the one hand the leather may not be entirely penetrated by the fatty substances, and on the other that the coloring material may be just sufficient in quantity to blacken the whole surface.

The composition is applied cold upon the flesh side with a brush, and is prepared by melting tallow, and mixing it thoroughly with enough oil and lampblack to give it the proper color and such a degree of consistence that it shall neither be too thick nor too thin to be applied in the cold state. For this purpose, the ingredients may be mixed together in the proportion of one pound of lampblack to twelve of oil and six of tallow. When this mixture has been smoothly and uniformly applied, the leather is placed upon the table, and any inequalities which may exist upon its surface, are smoothed down or removed by passing the flat of the hand over it, after which it is cleaned with a brush.

A second coating is now applied above the first, but

of a different mixture, made by thoroughly incorporating together (by grinding and not by melting) two parts of glue and one part of tallow. This is put on with a brush in the same manner, and with the same precautions as the first one, being smoothed with the hand, and at last *slicked* over with the lump of glass. Still another application is made to finish the preparation of the leather, and this consists in sponging lightly the whole blackened surface so as barely to moisten it with glue.

After this the skins are dried without exposure to the sun.

Calf-skins prepared in this manner acquire a degree of softness and suppleness which is not equalled by that of any other kind of leather, and they have been much employed in the manufacture of the legs of boots and of men's and women's shoes.

GRAINED CALF-SKINS.

The skins selected for the manufacture of this kind of leather are first moistened; and after the heads are pared down in order to equalize the thickness, they are pommelled from tail to head, placed on the table, and scraped with the stretching-iron. They are next beaten with the pestle in a tub of water; then smoothed out upon the marble slab on both sides, in order to reduce the natural grain of the leather, and dried until they have lost the greater part of their moisture. The blacking, of which we have already given the composition, is then applied upon the hair side, the skins are again smoothed out, and oiled upon both sides. They are dried, and deprived in the usual manner by means of potash or lye of the excess of oil upon the surfaces, and are then smoothed upon the grain with the stretching-iron. In order to

furrow the surface with the grain, the leather is then placed upon the table with the hair side up, and is pommelled first crosswise, and then from tail to head, taking care that the lines or grooves which correspond in direction shall be perfectly parallel. For this purpose a pommel is used with from forty-five to fifty teeth to the inch.

Another coating of black is now applied, and when this has been absorbed by the surface, oil and train oil scouring are brushed over in sufficient quantity for the requirements of the leather, which is then dried. The hair side is then pommelled in the same manner, and in the same directions as before. The borders are pared upon the horse with the round-knife, any injury to the form of the grained surface being avoided, and finally a light coating of pure and clear oil is spread over it.

CALF-SKIN LEATHER FOR BELTS.

For preparing this leather, the head and extremities are cut off, the skins are soaked in a tub until sufficiently wet, and then shaved upon the horse with the head-knife until they are of equal thickness throughout. They are then beaten in a trough with the pestle or rammer, dried, and lightly greased upon the flesh side with a mixture of equal parts of tallow and of oil, and upon the hair side with linseed oil alone. After this operation, they are dried, and worked upon the flesh with the stretching-knife, and *slicked* upon the grain with the glass. Sometimes a grain is given them as described in the last section.

CHAPTER XLVIII.

CURRYING OF GOAT-SKINS.

The preparation of these skins requires quite as much labor as that of calf-skins, and much more care and attention, on account of their greater thinness. The currier receives them dried after having been oiled. They are first softened by soaking for twenty-four hours in a vessel full of water; then are trodden out under feet three at a time, and scraped on the horse upon the flesh side only, with a blunt knife. When nearly dry, they are oiled with a mixture of train-oil scouring and oil, each dozen of skins weighing from twenty to twenty-two pounds, requiring from six and a half to nine pounds of oil. The oiling having been completed, they are again trodden out, scraped clean, and pommelled with instruments smaller than those used for calf-skins. In order to free their surfaces from the excess of oil, and to soften and brighten them, four ounces of potash are dissolved in two bucketsfull of water, and the solution is passed lightly over the grain side, the saponaceous compound formed by it with the oil being wiped off. The quantity of potash solution prepared will be sufficient for six dozen skins. After this, the leather is grained with the pommel, and is rubbed with a bunch of straw in order to soften the grain. It is then well wiped with a woollen rag, and

blacked with a mixture made of one ounce of powdered nutgalls, one pound one and a half ounces of copperas, and a small portion of Brazil-wood boiled for a short time in a little water, and then stirred about in a bucket-full of the same. Six skins are blacked at a time, and are then piled upon each other on the table or floor. The pile is then turned, so that those which were blacked first become uppermost, and each one, commencing with the one on top, is thoroughly wiped with a woollen rag, and is then stretched to dry.

When about three-quarters dry, they are blacked a second time with a hard brush, the color being rapidly and uniformly distributed over the surface, and they are then wiped with a pad or roller made of blanket-stuff, after which they are dried in the air. They are now pommelled across the grain, wiped, moistened with sour beer applied upon a piece of listing, and rubbed, to reduce the grain, with a bunch of rushes or of straw. When this operation is concluded, the borders are trimmed upon the horse, the skins pared with the round-knife, pommelled, and brightened with barberry-juice. This last operation requires care, and is performed by passing the listing, dipped in the polish, rapidly and lightly over the surface from head to tail end across, and continuing to rub while the rag remains moist, and until a polish is given. The roller is then applied equally and forcibly to the whole surface from head to tail; the skin is pommelled lengthwise and across, and is then dressed upon the grain with pure linseed-oil.

It was formerly the custom to form a diamond-grain surface upon goat-skins, but at the present day they are usually grained in straight parallel ridges, formed by pommelling from head to tail alone.

Another method of preparing goat-skins, which we proceed to describe, has been proposed by Larue, a Parisian currier.

Two skins are sprinkled at a time, upon the hair side, with water from a brush, and are then placed upon each other with their hair sides in contact, and after being folded up into a cap-like form, are beaten with the feet or with the mace. They are then pommelled from head to tail and crosswise, being at the same time partially and slightly moistened with water from the brush. A dozen or more skins having been prepared in this way, they are placed in a tub with a sufficient quantity of water to cover them, and are beaten out with the mace or rammer, after which they are stretched out smooth upon the marble with a stretching-iron, and dried partially. The hair sides are then washed over with a weak solution of potash, the skins are scraped upon the flesh with the stretcher, rubbed over with a bunch of straw, stretched again, and wiped with a piece of woollen cloth before being blacked. To make the color, one ounce one and a half drachms of powdered nutgalls, and one pound one ounce ten drachms of copperas, are boiled in a sufficient quantity of water until nearly dissolved, when the mixture is thrown into a bucket-full of water; a little Brazil wood is added, and the whole is well stirred. This is lightly spread with a brush over the hair sides, and the skins are then dried.

In a variation from this method, sometimes adopted, the skins are moistened with a solution of potash instead of simple water.

When dry, a second coat of color is applied to the skins with a hard brush made of hog's bristles, rapidly passed over the surfaces, and pressed upon them with

considerable force. After this, the hair sides are wiped with a woollen cloth made into a pad or roller, and are pommelled lengthwise. The edges are then pared upon the horse with the head-knife, the leather is scraped and wiped again, and finally pommelled either so as to produce parallel grooves or quadrilateral figures, the former being generally preferred in goat-skins. The blackened surfaces are finally polished by rubbing them with a piece of cloth or list dipped in barberry-juice, and after being smoothed by the roller, are oiled upon the hair side with pure linseed-oil, which completes the operation.

Morocco and fancy-colored goat-skins, after being dyed, require to be curried in order to bring them to their original suppleness. Those which are intended for shoemakers' use, require the utmost amount of pliability, and after being thinned on the flesh side, are rubbed over with the polisher, and then grained on the flesh side with a leaden or wooden pommel, channelled on the surface with fine parallel grooves. Finally, they are reglazed with the polisher, and then rubbed over with a cork-pommel.

Pocket-book and case leather, in general, require to be thinned evenly like the above, then slightly moistened, smoothed on the table by stretching, and dried again. The grain is imparted by passing them, when in a moist state, several times, in opposite directions, between cylinders which revolve nearly in contact.

Bookhout and Cochen, of New York, have invented a machine for smoothing, graining, and polishing, simultaneously, which does its work effectively and with dispatch. Below are two figures which represent the machine itself, in perspective, and the sliding head in

side elevation. In Fig. 174, *A A A*, is the framework,

Fig. 174.

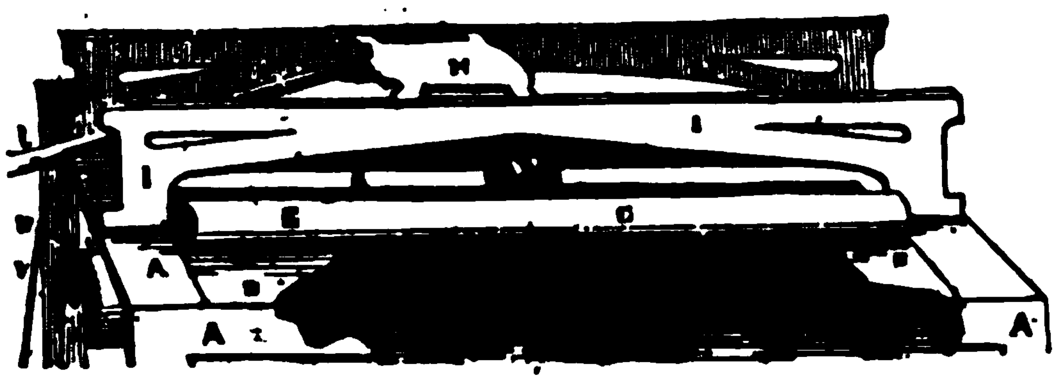
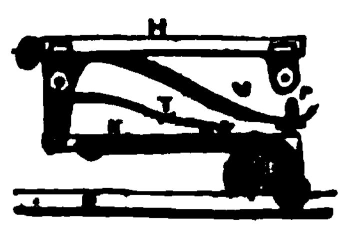


Fig. 175.



and *P*, a skin of leather passing over the rollers *C C*, which are made to revolve by means of a ratchet-wheel *K*, fastened to the back end of the roller. *H H* is the upper section of sliding head attached to the connecting rod *J*, whence it derives its backward and forward motion; and *I I*, are the ways on which it runs. These ways, as well as the clasps *G G*, and the feeding rollers, are parallel with the motion of the finishing tools *a a*, which are made of wood, metal, glass, stone, or horn.

This rolling-mill will finish about three dozen skins per *hour*, whereas the same number would be a full day's work for an expert hand-worker. It also answers for rolling heavy leather, and will smooth from forty to sixty sides per hour.

CHAPTER XLIX.

RED LEATHER.

This kind of leather was very largely prepared in former times, but is replaced, in a great measure, at the present day, by Morocco sheep leather; some of it, however, is still manufactured of a finer, but less permanent color than Russia leather, and without its odor. These skins have an average weight of twelve pounds, and are used by harness, coach, and trunk-makers.

Fine clean skins, with a uniform smooth surface, and which have not been tallowed, but have only received a light coat of pure oil, are selected for this purpose. They are dipped, pared, beaten under water, and dried in the ordinary way, and coated with pure oil on the hair, and a mixture of oil and oil-scouring upon the flesh sides, about half a pound of each being used for the purpose. A solution of alum in water, which probably acts as a mordant for fixing the color, is then rubbed over the hair side from head to tail with a brush, and, while still wet with it, the skins are softened by beating and rubbing them, after which they are pommelled, dried, and rubbed with a cork.

In order to prepare the color, about ten pounds of quicklime are slaked and dissolved in four buckets-full of water. On the third day, the clear liquor is decanted off, and the half of it is emptied into a copper boiler.

In order to make two buckets-full of color, eight and three-quarter pounds of Brazil wood are then thrown into this lime-water, and the mixture is rapidly boiled with constant stirring, until reduced to half the original quantity. It is then removed, and the remainder of the lime-water is emptied into the boiler and evaporated to one-half, when the first liquid is again thrown in the boiler; and, after adding nine drachms of powdered cochineal, the whole is boiled for a short time. While still boiling, a lump of lime, of the size of an egg, is thrown in, and the boiler is then removed from the fire and allowed to cool.

This quantity of color is sufficient for reddening eighteen or twenty skins. It is applied thoroughly upon the surfaces, being rubbed over in the direction from head to tail. The skins are then partially dried, coated a second time, entirely dried, and finally pommelled from head to tail. After this, they are brushed over a third time with the color, to which the white of an egg has been added, are dried, greased with an oiled woollen rag, and slicked smoothly with the glass, which is generally made like a muller. They are finally rubbed over in the usual way with barberry-juice, dried, and again strongly slicked.

Another process for reddening leather has been given by Dessables. In this, one pound one and a half ounces of alum is dissolved by boiling in a pint and a half of water, and the solution is poured into a large earthen pan, and mixed with six and a quarter pints of clean water. This quantity is sufficient to alum three dozen calf-skins.

Three and one-quarter pounds of Brazil wood, and a lump of fresh lime, of the size of an egg, are then boiled for five or six hours in four gallons of water.

The skins, being in the same condition as before being blacked, are rubbed over with a piece of wool dipped in the alum liquor, and after being well dried, receive three coats of the color in the same manner as before described.

CHAPTER L.

FAIR LEATHER.

THIS leather, used for the soles of ladies' shoes, is made, preferably, from hides tanned with Spanish oak. After having been soaked and scoured, they are separately spread upon a clean table and sponged on the grain side with the following mixture, reduced by dilution with water:—

The proportions for nine and a half pints, which is the quantity required for twenty-five sides, are—

Crystallized chloride of tin .	8	ounces
Muriatic acid, free from iron	4	fluidounces
Sulphuric ether . . .	8	"
Alcohol	32	"
Water	40	"

The tin salt is placed in a blue stone jar with the acid, and the whole is stirred until perfect solution is effected. The ether, alcohol, and water are then added and stirred in successively.

This process, patented by Prof. J. C. Booth, of Philadelphia, is founded strictly upon scientific principles. The tin-salt and acid are the bleaching agents, while the alcohol, ether, and water are diluents as well as protectives against any destructive tendency of the former. Its whitening effect extends throughout the hide, and is

not limited merely to the surface. After the application of the liquor, the leather is oiled, dressed, and rolled, as in the usual currying process.

This mixture is not applicable to leather tanned with black oak-bark, as it colors it yellow.

CHAPTER LI.

WATER-PROOF DRESSINGS.

THIS chapter contains an account of certain processes by which leather is said to be rendered water-proof; but, however efficient they may be, it is doubtful whether any such quality can be permanently imparted by the proposed treatment.

1. PATENTED PROCESS OF MESSRS. SMITH AND THOMAS.

The leather, which it is intended to render impervious, is first soaked for twenty-four hours in water, is then pressed between iron cylinders in order to remove the greater part of the moisture, and after being thoroughly dried by exposure to the air during some days, is steeped in the following mixture:—

Linseed oil	4 pints
Olive oil	2 "
Oil of turpentine	1 pint
Castor-oil	2 pints
Yellow wax	8 ounces
Pitch	4 "

The ingredients are mixed and boiled together in a large earthen pan, and, while in a state of ebullition, the leather is soaked in the mixture for a longer or

shorter time, according to its nature; sole leather being allowed to soak in it for twenty minutes, and cow and calf skins, the legs of boots, &c., for ten minutes or more. After being removed, they are drained and then pressed between cylinders covered with copper. They are then partially dried in a room in which a temperature of from 88° to 100° Fahrenheit is maintained; are pressed out again, and, finally, entirely dried at the same temperature as before.

2. PATENTED PROCESS OF M. NENORY FOR PREPARING ELASTIC AND IMPERVIOUS LEATHER.

Seventy-five pounds of linseed oil, and nine pounds twelve ounces of litharge, are first boiled with moderate heat, until the whole is reduced to two-thirds of its original quantity, and the oil thus prepared is set aside for use.

3 pounds 12 ounces of old linseed oil,
8 ounces of white wax,
2 pounds 12 ounces of glue,
2 ounces of verdigris, and
2 pounds of water are then mixed together and moderately heated in an iron pot, with frequent stirring, over a slow fire, until the ingredients are united in a uniform mixture.

50 pounds of the oil, prepared as above directed,
1 pound 8 ounces of the second mixture, above described,
5 pounds of yellow wax,
6 pounds 8 ounces of oil of turpentine,
1 pound of balsam of Peru,
1 pound of oil of thyme, and
3 pounds of white rosin, are then melted together

over a slow fire, without being boiled, and when the mixture of the ingredients is complete, the composition is poured into jars or bottles, to be preserved for use.

When required for use, one of the jars containing the mixture is placed near a fire, in order to render it sufficiently fluid for application to the leather. The boots or shoes which are to be made water-proof, are then well cleaned and brushed, and are rubbed over with a sponge or brush dipped in the composition; the operation being conducted either in the hot sunshine, or near a fire. This is repeated as soon as the articles are dry, until they are saturated with the mixture, and if any excess of it remains upon the surface, it is to be rubbed off with a thick cloth. By this operation, boots or shoes are said to be rendered completely water-proof, and to acquire an increase of suppleness, elasticity, and durability.

3. PROCESS OF M. J. DEANE, PATENTED IN 1844.

First Préparation.—1. Take of linseed oil, neats-foot oil, and rape-seed oil, 265 gallons, and reduce by boiling to 23 gallons.

2. A quantity of beef or mutton suet, rendered by melting, straining, boiling with clear water, straining again, and separating from the last particles of water by pressing between the folds of bibulous material.

3. 37 pounds 8 ounces of the suet thus prepared, and the same quantity of fresh wax are melted and stirred together with the oil No. 1, until mixed, at a temperature of about 150° Fahrenheit.

4. 2 pounds 3 ounces and 9 drachms of caoutchouc in shreds, are dissolved in 16 pints and 12 ounces of rectified oil of turpentine, at a temperature of 248°

Fahrenheit, the operation being conducted over a sand-bath.

5. 11 pounds half an ounce of Burgundy pitch are melted on a sand-bath, at a temperature of 194° F., in 22 pints 6 ounces of rectified oil of turpentine. The solution of caoutchouc, No. 4, is then mixed with it, and the whole is allowed to cool until it attains the temperature of 158° F., when it is mixed by stirring until the whole is cold, with the melted fat, wax, and oil No. 3.

Second Preparation.—11 pounds 9 drachms of yellow rosin are dissolved in 33 pints 12 ounces of rectified oil of turpentine, by heating over a sand-bath, at a temperature of 200° F., and when cooled down to 150°, the solution is added to a mixture of oil, wax, and suet, in the proportions directed for No. 3, of the first preparation.

Third Preparation.—22½ gallons of pure whale oil, and 16½ pounds of caoutchouc in shreds, are heated at a temperature of from 190° to 240° F., until the latter is perfectly dissolved.

Fourth Composition.—16½ pounds of shreds of caoutchouc are gently boiled over a sand-bath, in a quantity of oil of turpentine, sufficient to cover them, until they are dissolved. 22½ gallons of pure cod-liver oil, or whale oil, at a temperature of 194° F., are then added. When thoroughly mixed, the heat is allowed to fall to 150°, when 8 pounds 14 ounces of wax are added to the mixture, and the whole is stirred until cold.

The first two of these compositions are intended for the preparation of skins for uppers, and the last two for that of sole leather, and both kinds of leather are rendered by them more flexible and durable, and perfectly water-proof.

The portions of leather intended for uppers, are placed side by side, and upright, in a suitable vessel communi-

cating with a boiler. Either the first or the second composition is then placed in the boiler and heated to a temperature of from 122° to 212° F., when it is drawn off into the vessel containing the leather, until the latter is entirely covered with it. After being steeped in the mixture for two or three hours, the leather is exposed to a partial vacuum in an air-tight reservoir, by which the composition is made to penetrate its substance, and it is then dried in a current of warm air. The first composition is suitable for skins properly tanned with oak bark, and the second to those which have been tanned imperfectly, or by other materials than bark.

Thin sole leather is impregnated with the third composition, and the thicker kind with the fourth. The hides, or portions of them, are placed upon metal plates, heated to 104° F., and are repeatedly covered with the mixture by means of brushes saturated with it. They are then made to absorb the composition, and to dry at the same time, by exposure to a partial vacuum and currents of rarefied air in an air-tight chamber, constructed for the purpose.

Manufactured articles of leather are prepared by warming them, smearing them with any one of the above-described compositions, and drying at a moderately elevated temperature.

4. CHEAP AND SIMPLE METHOD OF MAKING LEATHER WATER-PROOF.

Two pounds of tallow, a pound of hogs' lard, a half pound of turpentine, and the same quantity of beeswax are melted together in an earthen pipkin. The boots and shoes are dried and warmed, and the composition is well rubbed into them, with a piece of tow dipped into

it; the articles being held near a hot fire until they have imbibed as much as they can take up. This mixture is used with very good effect by sportsmen. Another mixture for the same purpose, which is much used by fishermen, is applied in the same way. It consists of a pound of beeswax, a half pound of rosin, and the same quantity of beef-suet.

JENNINGS'S PROCESS

Is founded upon the double decomposition of metallic salts, by soluble soaps. The patentee dissolves any metallic soap in an equal quantity of raw linseed oil, and immerses the leather in the solution at 225°. When the latter has become cold, the leather is taken out and dried by exposure to air. Forty-eight hours suffice for the whole process.

This invention is also applicable to canvas and similar fabrics. One hundred and twelve pounds of soft soap being dissolved in 30 gallons of boiling water, the solution is then heated at 212° F., with 56 to 66 pounds of white vitriol (sulphate of zinc). An exchange of bases takes place, insoluble oleate of zinc and soluble alkaline sulphates being formed. The first rises to the surface of the liquor, and must be reboiled in fresh water to purify it of all soluble matters.

Five pounds of pearlash are next boiled with 50 gallons of raw linseed oil, until the mixture assumes a soapy appearance; and to it, while still hot, are added, and well stirred in, 2½ pounds sugar of lead, 2 pounds litharge, 4 pounds red lead, and 21 pounds black rosin. The whole is boiled for an hour during constant stirring, and at the end of that time, 30 pounds of the metallic soap are added. The mixture is subsequently treated with 2

gallons of a liquor made by dissolving caoutchouc, in the proportion of 24 ounces to one gallon of spirits of turpentine. The mixture must be allowed to cool to 160° F., and it may then be applied with a brush. Two, or at most, three coats suffice; but there must be a sufficient interval between each to insure perfect drying.

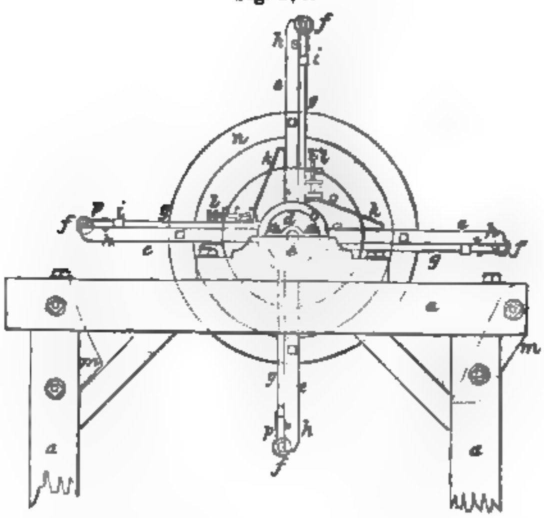
The salts employed give their own characteristic color to the mixture: for example, those of iron impart a brown, and those of zinc and lead, a white.

CHAPTER LII.

JACOB PERKINS'S MACHINE FOR POMMELLING AND GRAINING LEATHER.

Fig. 176, side view.
Fig. 177, front view.
Fig. 178, plan.

Fig. 176.



a. Framework held together by bolts with nuts.

b. Large horizontal wooden shaft, its iron pivot *c* turning in the copper collars *d*.

e. Four wooden arms radiating from the middle of the shaft *b*, and curved at their bases.

f. Four fluted or grooved cylinders of lignum vitæ wood, in the ends of the wooden arms. The grooves are near or far from each other, according to the grain intended to be given to the leather.

Fig. 177.

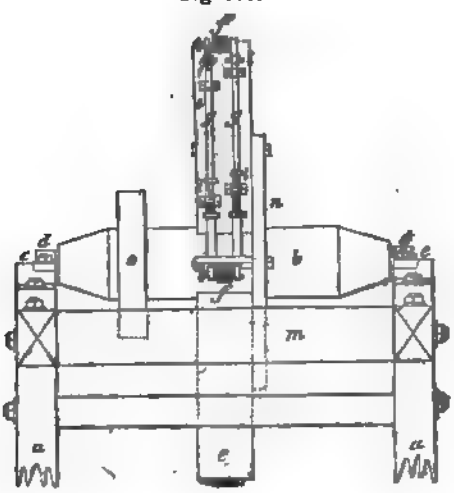
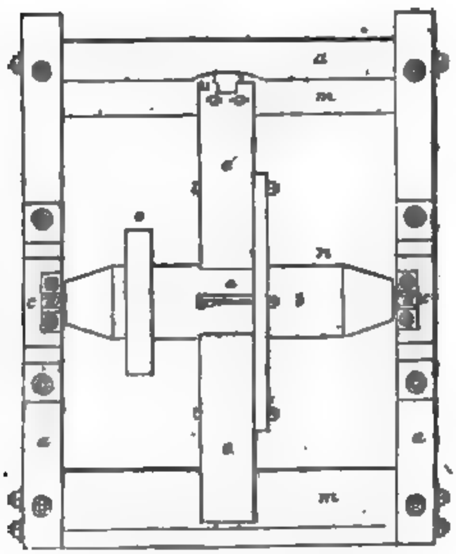


Fig. 178.



g. Two iron grooves attached to each of the arms, and receiving the pivots of the cylinders *f* in their extremities; these grooves are kept in place by the guides *i*, and slide against the blocks *h*, Fig. 176.

k, Fig. 176. Springs resting against the lower part of the base of the grooves *g*, and by their elasticity tending to push these grooves away from the shaft *b*.

l. Screw and nut, the end of which presses to the required extent upon the lower end of the groove *g*. When this screw is tightened, the groove presses down the spring, and approaches the shaft; when loosened the opposite movement takes place.

m. Pieces forming a support or frame, and curved in the form of arcs of the circle of which the shaft is the centre, so as to allow the arms to revolve freely. This frame should be very firm, and supplied with a surface of hard wood for the cylinders to rotate upon.

n. Circle attached by bolts to the arms, and serving to strengthen them.

o. Pulley upon the shaft *b*, intended to receive the motive power by means of a band.

The leather, when prepared in the ordinary way, and ready to be grained and polished, is placed upon the wooden table or frame *m*, and the shaft *b* is turned. The grooved cylinders *f*, stamp furrowed surfaces upon the leather, and, owing to the resiliency of the springs, adapt themselves to its variations of surface and thickness. The skin is moved about by the workman so that the different portions shall all be grained in the required directions, and during the process, the surface of hard wood *m* is from time to time moistened with water or oil, to prevent it from becoming heated.

The cylinders *f*, in the course of their revolution, press against brushes which keep them clean. Upon each of

their axles is a ratchet-wheel with a catch *p*, Fig. 176, the object of which is to prevent them from revolving. When the grooves of the cylinder are worn out at one point, they can be renewed by turning the cylinder round, so as to present a new part of its circumference.

The shaft, the pulley, the arms, and the circular support can all be made of cast-iron in one piece.

CHAPTER LIII.

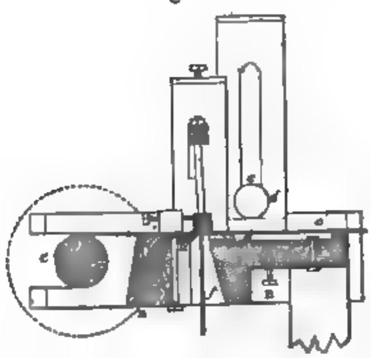
MACHINES FOR SPLITTING AND SHAVING LEATHER.

Leather sides and skins are subjected to the action of these machines, either to render them smooth and of uniform thickness by the shaving off of all irregularities or unevenness, or for the economical purpose of converting one side of thick leather into two, and rendering the latter serviceable for uses to which in their original thickness they would be inapplicable.

There are several machines for splitting leather, the most favorably known of which are the following:—

Degrand's Machine.—A transverse section of this machine is shown in Fig. 179. A horizontal knife *a*, longer

Fig. 179.



than the greatest width of a skin, is fixed upon a wooden table B. A cast-iron plate *b* is set in the table in front

of the knife-blade, and is intended to support the leather *c* at the desired elevation, its position being regulated by screws and nuts. It is movable in every direction, being supported upon four springs. Above it, a little wooden shelf *d*, which is pressed upon by a roller *e*, maintains the leather in close contact with the plate, so as to flatten and stretch it thoroughly before it is exposed to the blade. One of the separated surfaces of the leather, as it rises over the knife, is attached to a wedge-shaped tongue, which projects from the whole length of the wooden roller C, and is wound up upon the latter as it advances.

The leather is seen in the figure as split by the blade of the knife, the upper portion of it being already rolled upon the cylinder C. The lower half passes down under the knife through a slit in the table, and the uncut portion, which is about to be exposed to the action of the blade, is seen resting upon the table, and pressed down by the upper plate *d*. The movement of revolution is given to the cylinder by a winch which turns a pinion gearing with a toothed wheel at one of its ends. Two operations are required to split the leather, one-half of it being first separated, the skin being then unrolled from the cylinder, turned, and the split part attached to it, so that the other half may be in like manner divided.*

GIRAUDON'S MACHINE.—This interesting invention has been described by M. Armengaud, in the *Publication In-*

* The author has omitted to explain the mode of forcing the edge of the leather upon the knife-blade, by which the first part of the incision is effected. The process can only be rationally understood by supposing that a longitudinal incision is first made down the centre of the skin extending half through its thickness, and that, while one edge of the skin is attached to the roller [illegible] knife is accurately engaged in the bottom of the cut previ

dustrielle des Machines, outils et appareils, t. vi. liv. 9. The machine is simple in construction, operating rapidly and continuously upon the skins exposed to its action, and can be employed either for the purpose of dividing the leather into thin sheets or leaves, or for that of diminishing and equalizing its thickness.

The hide or skin which is to be cut is placed upon the circumference of a large drum or cylinder A (Figs. 180,

Fig. 180.

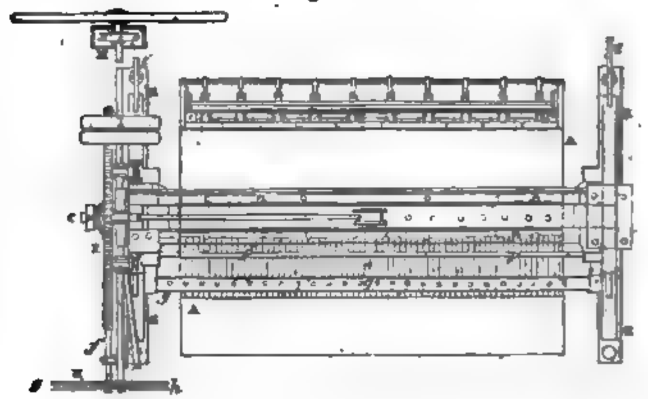
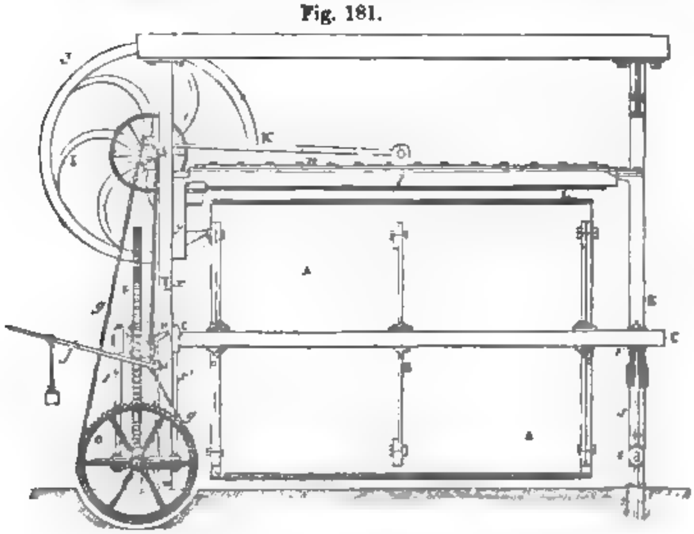
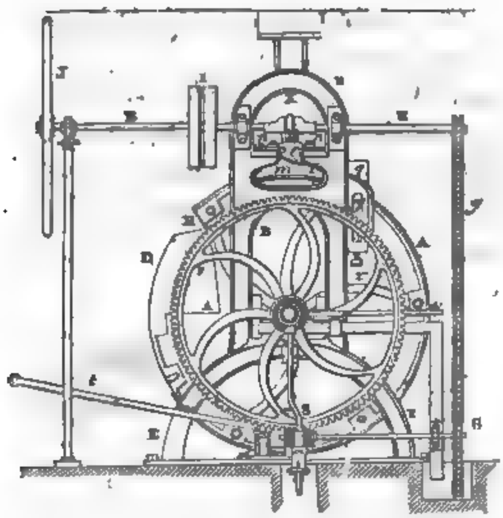


Fig. 181.



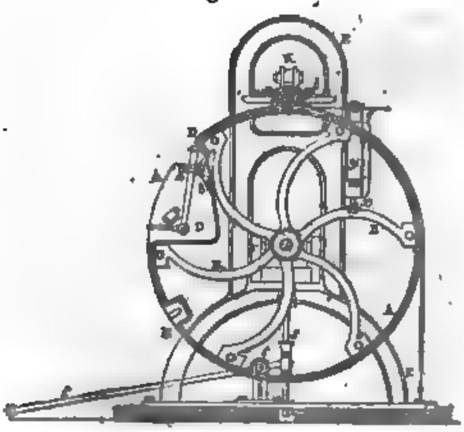
181, and 182), carefully turned and attached to three crosspieces with six branches or spokes B, which are con-

Fig. 182.



nected with the cast-iron horizontal shaft C. This cylinder is hollowed out, as seen in the section shown in Fig. 183, for the reception of a kind of pincers D (Fig. 189), which serve to support the extremity of one of the de-

Fig. 183.



tached portions of skin against the edge of the cylinder. For this purpose, these pincers are all mounted upon the same iron axle *a*, which rests upon small supports *b*, fastened to the cylinder, and they are kept in place by a flat, angular regulator.

The horizontal shaft C, which extends on each side beyond the cast framework E, carries at one end the larger cog-wheel F, which is geared with the endless screw *e* (Figs. 184 and 185), situated at the lower part

Fig. 184.

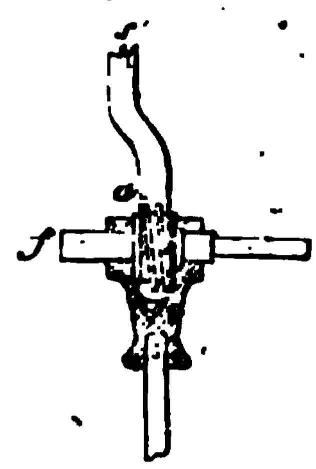
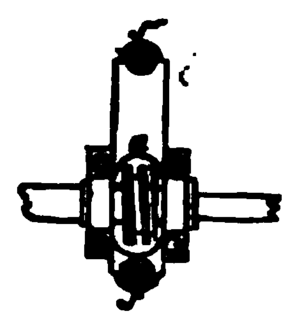


Fig. 185.



of the machine, and revolving upon the axle *f*, the slow movement of which is produced by means of the wheel

Fig. 186.

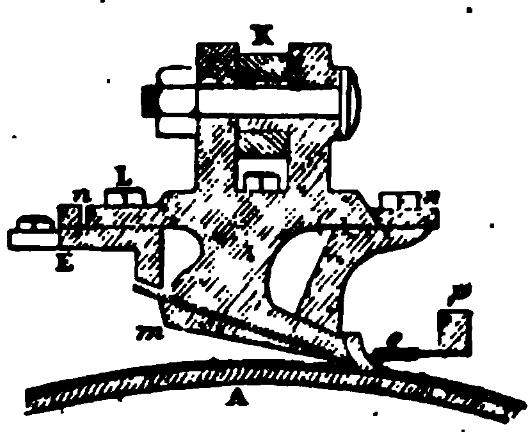


Fig. 187.

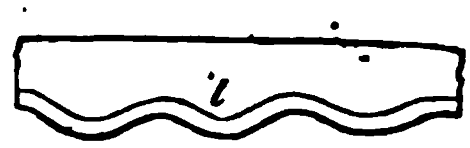
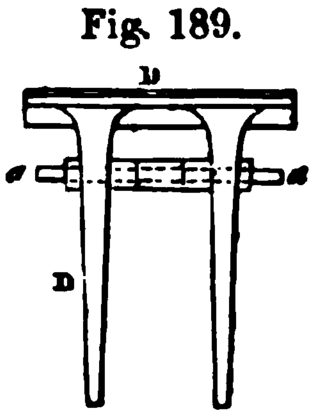


Fig. 188.

G, the endless chain *g*, and the pinion *h*. This pinion turns upon the cast-iron shaft H, which is made to revolve by means of a strap passed over one of the pulleys I; a fly-wheel J giving the necessary uniformity to the motion. A roller *i*, at the end of a counterpoised lever *j*, presses against the endless chain, and gives it the proper amount of tension.

Fig. 189.



The shaft H is elbowed in the middle, so as to form a crank for the head of the cast-iron rod K, which is articulated at its other end with the middle of the movable rabbit or carriage L (Figs. 183 and 186). At the base of this is attached the long cutting steel blade which is inclined a little in direction to the horizon, and touches the exterior of the cylinder when made to approach it. It is very thin and of an undulating form, as shown in the plan (Fig. 187), so as to act upon the leather like a saw, the teeth of which are rounded off; by which arrangement it cuts more easily and with less wear of edge. This knife-blade is attached to the base of the rabbit by means of an iron plate *m*, the position of which can be accurately adjusted with a screw.

The movable rabbit or carriage, is dove-tailed into the tops of two cast-iron supports E, which compose the framework. The grooved plates *n* above it, prevent any deviation from the reciprocating rectilinear movement produced by its connection with the crank. Thus the same shaft H which moves the crank, causes the revolution of the lower axle *f*, and of the endless screw, by means of which the drum upon which the skin is wound, is also turned; but with a motion exceedingly slow, when compared with that of the crank above; and the knife connected with it. The ratio of size between the pinion *h*, and the wheel G being as one to eight, and the large wheel F having 244 teeth, it follows that the cylinder only turns once while the axle *f* and the endless screw are making 244 revolutions, and the main shaft H is making 1952. By causing the main shaft to revolve 75 times in a minute, the knife is made to cut the leather 150 times, so that a skin 78.74 inches in length will be split in 15½ minutes.

The leather is maintained in close contact with the

cylinder in front of the knife-blade, by the pressure of a series of flexible spring-keys which adapt themselves to its irregularities of surface, and keep its uncut edge firmly pressed down, by means of a crosspiece extending along its whole breadth, and supported by projections upon the inside of the framework. A strong bar *g* serves to support the other ends of the springs, and also assists in keeping the leather applied to the surface of the cylinder. Two grooved uprights *y*, are adjusted in rectangular vertical mortises of the framework, and the screws *x*, in their lower parts, regulate the height of the bar.

The lower separated portion of the split leather remains in contact with the cylinder while it revolves, and the upper part may be rolled off, if desired, upon a roller placed above the machine.

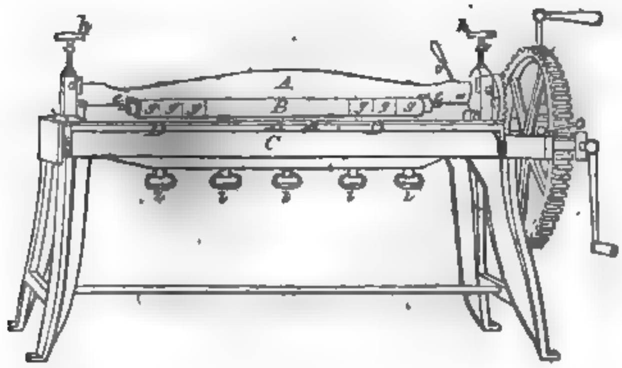
When a skin is divided throughout, in order to replace it by a fresh one, it is necessary to lower the cylinder from its position, in order to disengage the knife from the surfaces. For this purpose, the cushions *r* of its axle are adjusted in movable collars supported upon uprights *s* and *s'*, which can be elevated or lowered by means of iron swipes *t*, which are supported upon the base of the framework E, and are connected by a crossbar, or treadle, which the workman can lower by a pressure of his foot, the collars and uprights being only movable in a vertical direction. In order that the cog-wheel and the screw may continue in gear during this change of position, the cushions which support the axle of the latter are connected with the crossbar between the two uprights.

The revolution of the cylinder can be stopped at pleasure by ungearing the wheel E, which can be moved upon its axle by the handle *u* and fork *v*.

Thirty-six raw hides can be readily divided by this machine in a day of twelve hours.

RICHARDSON'S MACHINE.—This machine, the invention of Alpha Richardson, of Massachusetts, is that generally used throughout the United States. It serves for splitting either green or tanned hides. There are two modifications, that shown in perspective, by Fig. 190, is

Fig. 190.



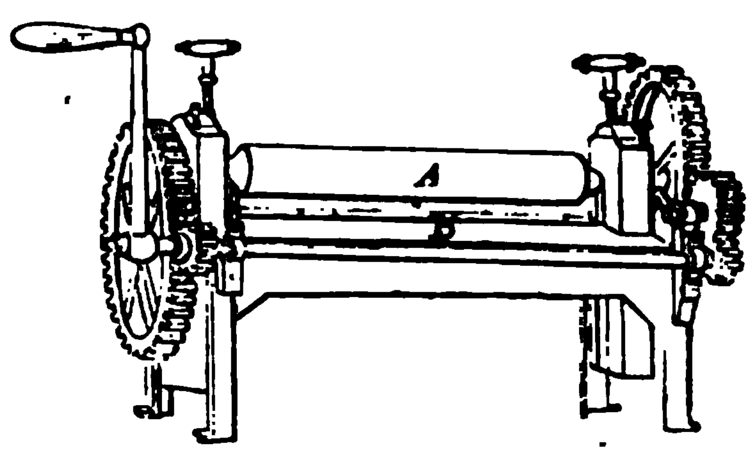
intended for splitting upper leather, which is drawn between the knife and roller, by means of a crank and windlass. This is styled the Tanner and Curriers' Machine. *A* is the cast-iron piece connected with the gauge-roller *B*, which revolves on the centres *e e*, and is turned up by the lever *o* to allow the placing of the leather upon the top of the knife and back-spring *A A*. The skin being in right position, the gauge is then turned back, and forms the gauge for the thickness of the skins which may be regulated at will, by means of the screws *h h*. *B* is the roller with the sectional tubes *g g g*, which are arranged to turn on its end, and to serve as friction-rollers when the shanks and loose part of the skin are being drawn through. The knife *D* is bolted, firmly, to the bed by the screws *i i i i*. The leather is placed upon the cylin-

der *C*, and drawn through against the knife *D* by the aid of the crank at the end of the machine.

The leather is prepared for splitting by being only partially dried. In New England and in the middle States it is generally split before it is wholly tanned, as the quality of the leather is thought to be improved by finishing the tanning after it has been thinned or divided by the machine.

The other modification of the machine is constructed for splitting and skinning sole leather, welt leather, and stiffenings for boot and shoemaker's use. It is represented by Fig. 191, and works by means of rollers which

Fig. 191.



force the leather against the edge of the knife. *A* is the gauge-roller, which is regulated by screws according to the thickness it is desired to split the skin. *B* is the lower roller, which forces the leather, or hide, against the knife, and the two are put in motion by the crank, &c., at the end. The leather must be damped through before being placed in the machine.

Seguin's Shaving and Smoothing Machine.—This machine consists of two metallic rollers, each six feet six inches long; one of them five and nine-tenth inches in diameter, having a cutting-blade set spirally into its surface, and intended to pare the skin wrapped around the other roller, which is two feet five inches in diameter. A longitudinal groove in the surface of the lower roller re-

ceives the end of the hide, which is kept in place by means of wedges. The cutting-blade begins to form a spiral at the middle of the upper roller, and makes the entire circuit on both sides before reaching the ends. The pivots of the lower roller turn in two fixed supports, and those of the upper one in two levers, by means of which it can be lowered upon, or raised from the surface of the first one. These rollers turn in opposite directions, and their motion is so adjusted that the lower one turns completely around once, while the upper is making twelve revolutions.

The end of the leather having been engaged in the groove, it is gradually wound upon the roller, while the levers upon which the upper roller turns being charged with smaller or greater weights, as the case requires, the skin, with its grain side up, is shaved from the centre to the sides, throughout its whole extent. Fig. 192 is a front view, and Fig. 193 a side view of this machine.

Fig. 192.

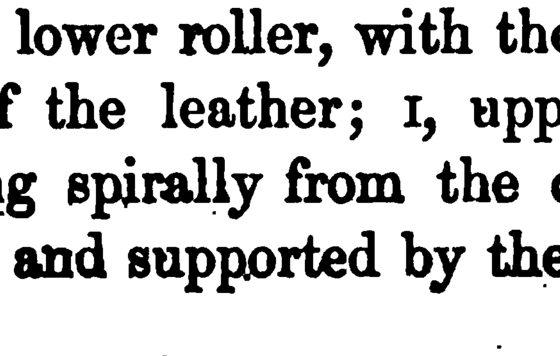
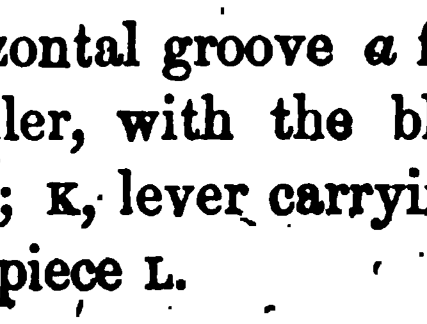


Fig. 193.



H, the lower roller, with the horizontal groove *a* for the end of the leather; I, upper roller, with the blade *b*, curving spirally from the centre; K, lever carrying the roller, and supported by the crosspiece L.

NOSSITER'S PROCESSES.

These improvements, patented, in England, October 10, 1845, are:—

1. For a mode of shaving tanned or dressed hides and skins, by applying knives set tangentially to a rotatory axis, in place of performing such operation by hand.

2. A mode of causing the grease, or oil of sheep, lamb, and other skins, requiring such process, to be expressed out by means of rollers.

3. A mode of unhairing, fleshing, and removing grease and filth from hides and skins, by the employment of a rotatory axis with knives or blades.

Fig. 194 "shows a section of so much of a machine as will enable me to describe this part of my invention: *a* is a roller, on which is fixed a series of knives, *b*, fixed tangentially; and although they will act very well when in a line with the axis, yet I prefer them to incline across the axis to a small extent, so that each blade may come into action progressively, and not all parts at the same moment; *c* is a bed, or surface, covered with copper, to prevent the iron staining the leather; or other suitable

Fig. 194.

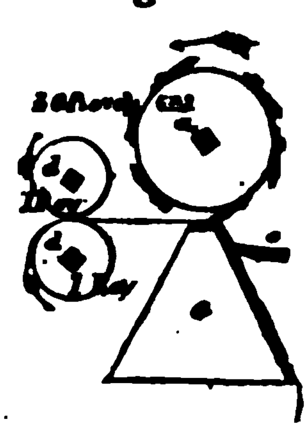
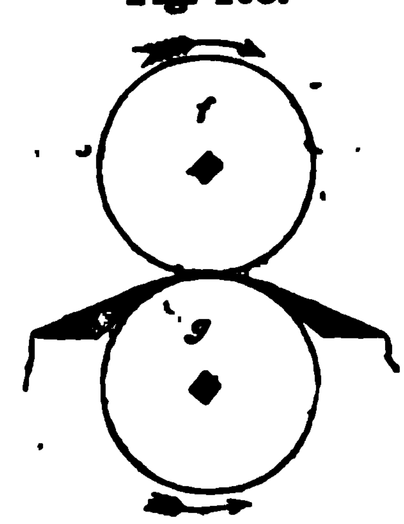


Fig. 195.



bed may be used: *d d*, are two rollers, which draw forward the skins, or hides, so that the skins, or hides, may be held tightly over the bed, *c*, and, in introducing the hides, or skins, the revolving cutter is raised off the bed. The speed at which the parts move are written thereon, but the same may be varied. By this arrangement of machinery, the knives will shave or cut the hides and

skins submitted to its operation, so as to reduce the thickness to the degree desired, and this in a more uniform manner than when performing the same process by hand-labor, with suitable knives, as heretofore generally practised."

The second part of the invention is illustrated by Fig. 195: "*f g* are two smooth rollers, between which the skins are passed; the surface of the upper roller being pressed closely down, so as to offer a sufficient pressure to remove the grease and oil from the skins when in the 'pelt' state; and this means of performing this process will be found more useful than the means of pressure now resorted to."

The third part of the invention is shown in Fig. 196: "*h* is a roller, having a series of blades of steel, or other suitable material, set radially from the axis; each blade should be as long as the roller on which it is fixed, so that each blade may be as wide as the skin submitted to its action. This mode of working is to be substituted

Fig. 196.

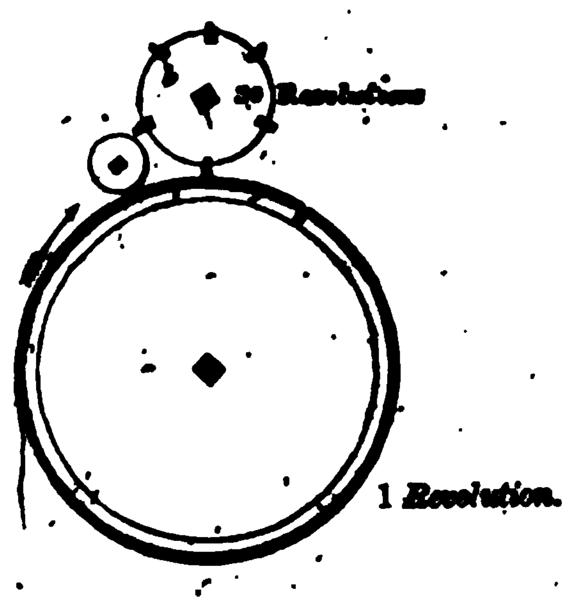
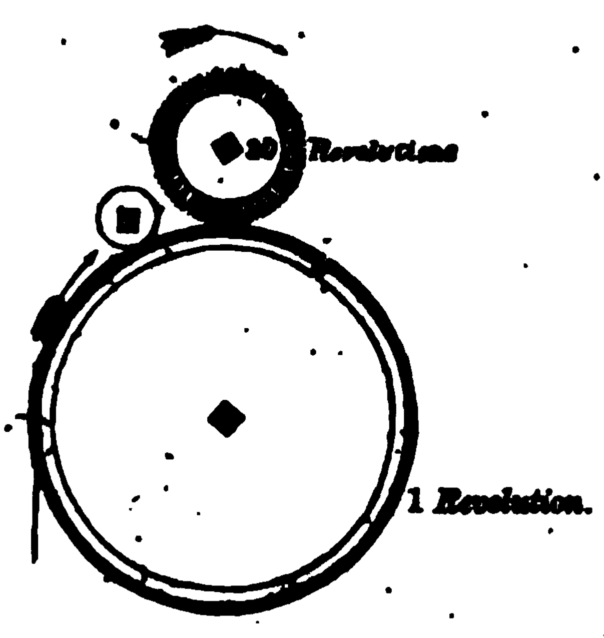


Fig. 197.



for the hand-working with knives now resorted to for unhairing and fleshing, and also paring or graining hides and skins; and I use a cylindrical rotatory brush (Fig. 197), for removing the surface-grease and filth from the hides and skins."

CHAPTER LIV.

EMBOSSING OF LEATHER.

This is a method of manufacturing ornamental leather intended for furniture, hangings, bookbinding, and other uses.

BERNHEIM AND LABOURIAU'S PROCESS.

The plates, by means of which the figures in relief are stamped upon the leather, in this process, are made of type-metal, or fusible alloy, cast in plaster moulds, on which the reverse of the figures has been designed. The type-metal plates are used for stamping leather without the assistance of a press, by which they would be broken to pieces, and those of fusible alloy are employed for large single designs in panel upon hangings, or for the repetition of the same figures, by associating a number of plates together. For this latter purpose, as many plates as are necessary for the whole design are placed together upon a level surface, in their proper places, and their edges are then joined together, first by running a hot iron along them, and then by filling up the interstices with melted fusible metal. The projecting veins of metal are then cut and scraped off, and the whole presents the appearance of a single plate.

The large plates thus prepared, will not bear the force of a press, but are used with the assistance of heat. The ingredients of which the alloy is composed, are not in the proportion to make the most fusible metal, the quantity of lead being somewhat greater than in the ordinary alloy. Those plates which are intended to be subjected to the action of the press, also, have a smaller quantity of tin in their composition than is usual, so as not to be rendered brittle by an excess of it. These latter should be perfectly smooth below, and should be of considerable thickness. They are prepared of the proper thickness in the following manner: A fine thin sheet of tin-foil is first pressed into all the cavities of the original plaster mould, so as to give a reversed copy of it, and a plate of softened wax of the desired thickness of the metal plate, is forced into it so as to take its form. A plaster mould is then taken of this wax impression, covered with tin-foil, and the model and the mould, placed parallel to each other, are separated by little leaden tubes, which are equal in height to the thickness of the wax-plate before used.

In order that the casting should be successful, the plaster models and moulds must be perfectly dry, and heated to the temperature of the fused alloy, and when filled must be placed in a position to cool rapidly.

The large compound plates are exposed, in stamping, to the action of heat by means of pipes conveying steam, placed below them.

Two means of stamping leather with figures in relief are resorted to, that by the use of the press, and that in which the stamping is effected by hand or the chisel, with the assistance of heat. The leather is first fulled in tepid water, until it becomes as soft as it is possible to make it. In this condition it is placed upon the plate without being stretched, and is made to enter

all the depressions of the figures by pressing and squeezing it in every direction with the fingers, while the projections and folds upon the edges of the design, are smoothed down by a wooden instrument like the chisel used by sculptors. When the leather is in contact with all parts of the mould or plate, if the character of the figures is such as to admit of perpendicular pressure, the frame is filled up with warm sawdust, and the gentle force of a press is applied above, so as to keep the leather and metal surfaces in contact. After a time, the screw is loosened, the moistened sawdust is removed, and replaced with fresh, the press is again brought to bear, and this process is repeated once more. At the end of the third operation, the leather will generally have acquired enough consistency to retain the form impressed upon it, and it may then be removed from the plate and dried in the stove-room.

If the plate be too large for the press, or if there are many projections on its surface, having slight or narrow bases, the pressure must be conducted entirely by hand. For this purpose the plate is warmed by placing it upon the tubes conveying hot air or steam, and the moistened leather is laid upon it, and forced down into all the depressions and grooves of the plate by means of paper-hangers' paste, which is thrust and pressed down into them with the end of the wooden instrument or chisel, and when the chief cavities are filled in this way, the rest of the surface is worked so as to bring the leather in contact with the plate in every part. The folds which form at the borders and corners, are then smoothed out with the chisel, first longitudinally, and then across, until they are made to disappear. The whole surface of the leather is then rubbed with a dry sponge so as to remove the excess of moisture, and the workman

then continues forcing it down into the depressions with a chisel, until it is perfectly dry, when the rest of the paste is removed from the hollows. The elasticity of the leather, when dry, allows of its removal from the plates even when the elevations on the latter are larger at top than at bottom.

If it is intended to stamp a design, or series of designs, the dimensions of which require the use of a number of skins, the latter are first cut into parallelograms, and their edges are pared and thinned down. One of them in the softened state is then placed at an angle or edge of the plate, and is impressed with the figures in the manner before described. A second skin is then placed alongside of the first, with one edge projecting about an inch over its border, and is printed in the same way; a third is placed next to and partly over the second, and so on, even if a number of rows of skins are required, until the whole extent of the plate is occupied. After the skins have all been pressed, sponged, worked with the chisel, and dried, their overlying edges are gently raised, covered with strong glue, carefully replaced, and retained in their original position, by covering the whole with sawdust and weighted planks, until it dries and forms a continuous sheet.

By these two processes, leather beautifully ornamented in relief, and suitable for many purposes of luxury, may be manufactured. These ornaments may be allowed to retain, in a slight degree, the suppleness and elasticity of the leather, or may be rendered perfectly firm and hard, by pouring into them, while still warm upon the castings, a solution of gum-lac in alcohol, or a watery solution of glue, and filling up all the depressions with paste, sawdust, or, what is still better, the raspings of cork mixed with glue. Their surfaces may be made impervious to

moisture, by the penetration of the gum-lac or of other resinous material, and may be painted, gilded, and varnished.

F. W. EAST'S PROCESS.

This invention, patented in 1851, differs from the usual method in being exclusively applicable to the flesh side of leather, and thus producing an effect superior to that obtained by embossing the grain side. It is adapted to all tanned skins except those which are oil-tanned.

The skins, just sufficiently shaved to remove flaws and give them uniform thickness, are to be immersed in water of 120° F., and brushed on the flesh side to remove dirt and open the fibre. They are then to be folded grain-side inwards and the edges sewed together in bag form, so as to prevent the intrusion of the dye. The dyeing succeeds "scouring," and "sweetening," and is effected with much weaker liquors than are used for dyeing the grain side of skins; but requires a longer time, as the process must be several times repeated in order that the color may penetrate the fibres, and appear uniform. They are then rinsed, opened, and dried.

When dry, they are to be "perched" on the flesh side with a moderately sharp knife, so as to soften the fibres, and nap the surface without cutting the flesh off. Each skin is to be again folded as before, and passed through a glutinous solution of one part, by measure, of size in three parts of water; then stretched on boards to dry, trimmed around the edges, and bruised on the surfaces with cork, to render them soft, the flesh side being kept outwards.

The skins, just previous to being embossed, are moistened on the grain sides with clean water, and then laid

together, with the grain sides in contact, and under cover in order to prevent access of air, and thus to promote the thorough penetration of the water through the hide, thereby making the gelatinous matter auxiliary to the production of a gloss upon the embossed parts. The embossing is done with engraved rollers, previously heated to 250°, and exactly in the same manner as is employed for embossing velvet, cloth, &c.

CHAPTER LV.

GUT-DRESSING.

THE art of the gut-dresser consists in separating the middle or muscular coat of the intestines of certain animals from its external or peritoneal covering, and from its internal lining or mucous membrane, and may be divided into two distinct branches; the preparation of the intestines of oxen and cows, for the preservation of alimentary substances, and that of the intestines of sheep, for the manufacture of cords for various purposes. These subjects will be treated of under their appropriate headings.

PREPARATION OF THE INTESTINES OF CATTLE.

The workshop of the gut-dresser generally consists of a room about 20 feet long, 16 feet wide, and 12 feet high, with four windows which are kept closed in winter, and are opened in summer. Casks or tubs, each capable of containing about 60 gallons, are ranged around its sides; and wooden stakes are fixed in the ground in the middle of the room, for attaching hooks. The feculent matters, and the remnants from the intestines, are usually allowed to lie about the floor, and exhale an odor, which, with that from the putrefying intestines in the tubs, is the most disgusting that can be conceived, and is so perma-

nent, that the bodies as well as the clothes of the workmen remain for a long time impregnated with it.

A well is usually sunk in a yard attached to the building, for receiving the excrementitious and waste matters of the manufactory.

The intestines are subjected to various operations, which will be described in order.

The small intestines of oxen and cows, as soon as they are brought to the workshop from the slaughter-house, are steeped in water contained in the casks, in order to moisten and smooth the surfaces, so that the knife may glide easily over them. When this is accomplished, an end of one of the intestines is attached, by tying it in a kind of knot around a hook, to one of the stakes in the centre of the room, at a height of six or seven feet above the floor. The workman, then grasping the depending portion between the thumb and first finger of the left hand, and gradually sliding the hand down along the whole length of the intestine, follows its motion by passing a knife held in the right hand, over the surface, so as to separate the fat, and as much as possible of the outer or peritoneal coat. Another portion of gut is then treated in the same way, and the operation is continued until all the contents of the casks have been cleaned.

If any parts of the intestine have been scratched or divided by the butchers in separating the fat, these are cut off and thrown aside. The fat falling to the ground is separated from the feculent and other matters, and after being washed a number of times, is dried, melted, and rendered.

The intestines are next washed in a large cask half full of pure water, and the workman then proceeds to turn them inside out, by introducing a thumb into the interior of each, and working the gut upon it with the

35

fingers until the whole is inverted. A number of the pieces are then tied together at their ends with a cord which is attached to the edge of the cask, and when a sufficient number of inverted intestines are thus fastened, they are left with only their original contents of water, to undergo the next process, that of putrefaction.

The experience of the workman alone can guide him in determining when putrefaction is sufficiently established. It should be carried only far enough to disorganize the mucous membrane and other parts which are to be separated from the middle coat of the intestines; and if allowed to advance too far, the whole tissue will be softened and rendered useless.

Two or three days' exposure in summer, and from five to eight in winter are usually sufficient, and putrefaction is known to have reached the proper stage, when bubbles of gas begin to escape from the surface of the intestines. This operation is the most disgusting one to which the workmen are exposed, from the fetid effluvia generated by the decomposing animal matters; but it does not seem to be as injurious to the health of those working in the room as might be supposed.

When sufficiently rotted, the pieces are untied, soaked in a cask half full of fresh water, and the next operation consists in separating the disorganized mucous lining, which is now upon the outside. This the workman proceeds to effect by scraping it off with his thumb-nails, until it is entirely detached. The operation is facilitated by dipping the pieces frequently in water. The intestines are then repeatedly soaked and washed in clean water until it comes from them unclouded and free from taint.

When perfectly clean, one end of each piece of intestine is tied with a string, and the workman introduces

into the other orifice a hollow cylinder of cane angle or reed about five inches long, and after making the joint air-tight by pressing the rim of the gut tightly around it, applies his mouth to the end, and expands the gut by blowing into it, and then closes the orifice, tying it tightly with a cord. If holes are found, the intestine is cut off at the place where they occur, and tied again with a cord. When all the pieces are thus filled with air, they are carried in baskets to the drying place, and are laid out so as not to be in contact with each other, upon horizontal poles placed about five feet from the ground.

When perfectly dry, the pieces of gut are taken down, and cut across with scissors as near the ligatures as possible, after which they are pressed and flattened with the hand, so as to expel all the air contained in them.

They are then assorted into different sizes according to the purposes for which they are intended, are collected in bundles, and hung in a damp place, preparatory to being subjected to the action of sulphurous fumes.

After being kept in a damp situation for some time, the intestines are exposed to the vapor of sulphur in a stove or chamber, five and one-third feet square, and six and a half feet high. For this purpose, they are strung on sticks, and if not sufficiently moist when introduced into it, they are sprinkled over with water from a brush, and are then suspended across the upper part of the chamber to the number of a hundred bundles. A pound or more of flowers of sulphur is then put in an earthen dish in the bottom of the chamber, and ignited by burning coals thrown upon it; the door of the chamber being immediately closed, and the further precaution to prevent the escape of vapors being taken of luting it around the edges, and of gluing stout pieces of paper upon any apertures which exist in the stove.

At the expiration of some hours, the door is opened and the vapors are allowed to escape. The intestines, by being thus exposed to the action of sulphurous acid, are bleached, deprived of their unpleasant odor, and are protected against the attacks of insects. While still damp, they are twisted into hanks, packed with camphor, and sent to market.

DISINFECTION OF THE WORKSHOP, AND MODE OF SUPPRESSING PUTREFACTION.

In order to prevent the offensive effluvia arising from the putrefaction of intestines, the following process of separating the mucous membrane has been devised by Labarraque, who received, as a reward for it, the premium of the French Society for the Encouragement of National Industry.

The small intestines of fifty cattle, which have been cleaned and turned inside out, are mixed in a cask with two buckets-full of water containing three and a half pounds of chlorinated liquor of potassa, at 12° or 13°; and if there be not then enough liquid to cover them, another bucket-full of fresh water is added. The whole is then stirred about, well mixed, and left over night. The membrane can be detached as easily the next day, as after many days of putrefaction in the ordinary method, and the noxious and unpleasant odor is entirely avoided. The succeeding operations are performed in the usual manner.

GOLDBEATER'S-SKIN.

Goldbeater's-skin is prepared from the external or peritoneal coat of the cœcum, or blind gut of neat

cattle. The workman separates and turns over the portion which encircles the junction of this pouch with the rest of the intestines, and draws it off inverted, from the other coats, to the length of twenty-five or thirty inches. It is then immersed for a short time in a weak solution of potash, and is cleaned by scraping upon a board with a knife. When well cleaned in this way, and by soaking in water, the piece is stretched upon a kind of frame from forty to fifty inches in length, and eleven inches in width, and made of two uprights held together by two crosspieces, having longitudinal grooves two and half lines in width. The surface of the membrane which was outside in the animal, is placed in contact with the upper part of the frame, and one end being placed upon the top of the frame, it is stretched in every direction, and is glued to its rim. Another membrane is then stretched above the first, with its external surface placed upwards, and is attached to it by gluing around the edges. When perfectly dry, the membranes are separated by running a sharp knife along the grooves. Each strip is then glued upon a frame similar to the first one, but without a groove, and is washed over with a solution composed of an ounce of alum dissolved in four pints of pure water. When the surface is dry, a sponge dipped in a concentrated solution of fish-glue in white wine, with enough cloves, nutmegs, or camphor, to make it aromatic, is passed over it. When this coating is dry, it is covered with a coat of white of eggs, and the strip is cut into pieces five and a half inches square, which are then smoothed out under a press, and made up into leaves for the purpose of the goldbeater.

LATHE-CORDS.

These cords are made of the intestines of horses, cleaned and prepared by the separation of the mucous membrane, in the manner before described. A wooden ball, armed in its lower part with four cutting blades, at equal distances from each other, is fixed by an upright piece of wood to a bench. The end of an intestine is then drawn over this ball, and as the gut is pulled downwards, it is divided into four equal bands or strips.

Four or eight of these strips, according to the thickness which it is intended to give to the cord, are tied with a peculiar knot to one end of a thick piece of cord. The end is passed around a peg introduced into a hole in a solid post, to the side of which a number of pegs are attached. At a distance of ten or eleven yards from the first one, another post is fixed, similarly provided with pegs, and over one of these latter, the middle of the assemblage of strips is passed, the other end being brought back and attached to the first peg, by means of another knotted cord. The tied ends of the strips are then attached to the wheel by a hook connected with the *whirl*, which is made to revolve until the strips are sufficiently twisted. The twisted end is then kept stretched by attaching it to the peg, and any projecting filaments are cut off. After being stretched for some time, the cords are then twisted again, and a third and a fourth time are twisted by hand, being each time rubbed with and drawn through a bunch of moistened horse-hair after the twisting, and again stretched out between the two posts. If the cord is not smooth and even after the twisting is completed, it is made so by rubbing with a piece of dogskin. It is then dried, and, by some manufacturers, is

exposed to the vapors of sulphur. Finally, the ends are cut off, and the cord is rolled in a coil.

In order to avoid the emanations from the putrefying intestines, which are generally brought to the workshop in a state of incipient decomposition, Labarraque recommends that they be at once cleaned, turned inside out, and put to soak over night in a cask, containing, for fifteen or twenty intestines, one pound one and a half ounces of chlorinated potash liquor at from 13° to 18°, mixed with two buckets-full of pure water. The mucous membrane is ready to be detached the next day, and after its removal and thorough washing, the intestines can at once be prepared, as has been already described.

MANUFACTURE OF CORDS, IMPROPERLY CALLED CAT-GUT, FROM THE INTESTINES OF SHEEP.

The intestines are removed from the body of the animal when warm, are cleaned and freed from fecal matter, and are at once sent to the workshop. If not perfectly clean at first, and if decomposition has been allowed to commence, they are indelibly stained, so as to be unfit for most of the purposes for which they are intended.

After being unravelled and deprived of adhering fat, while soaking in a tub of water, they are placed in fresh water, and the small ends of all the intestines are tied together, and laid on the edge of the tub, while their bodies are left to steep for two or three days in water, which is frequently changed, particularly in summer. By this means, the removal of the mucous and peritoneal coats is facilitated. After this, the bunch of intestines is placed upon a bench which slopes down towards the edge of the tub, and the surface is scraped with the back of a knife-blade, in order to separate and remove

the external membrane in breadth of about half the circumference. This coat, which is called *filandre* by the French manufacturers, can only be freely removed in pieces of the proper size and length by pulling it off in the direction from the small to the large end of the intestine. It is employed as thread to sew intestines, and to make the cords of rackets and battledores. In the event of its breaking, the separated pieces must be tied together, and they and the others are laid aside for use.

The guts are then soaked in fresh water for twenty-four hours more, and are taken out and scraped clean upon the bench with the back of a round-bladed knife. About eight feet of the larger ends are now cut off and sold to the sausage-makers. The rest are then cut of a proper length, and are imbedded, as it were, between layers of salt. Alternating heaps of intestines and layers of salt are packed in until all the intestines have been salted. After some days, they are removed and packed with a small quantity of salt, so as to be ready at any time for the succeeding processes.

After this *curing* is completed, the intestines are taken out and soaked over night in fresh water, and the following day are deposited in a lye made by adding four ounces of potash and the same quantity of pearlash, to a pail of water, containing about three or four gallons. The exact strength of the lye is determined by the experience of the workmen, and the effect which it has upon their hands. The lye is poured in successive quantities upon the intestines, and is poured off again every two or three hours, until they have been sufficiently acted upon. They are then drawn two or three times through an open brass thimble, and pressed against it with the nail, in order to scrape off unnecessary and pro-

jecting parts from the surfaces, after which they are selected for different purposes, according to their sizes.

Cord for Rackets.—This is generally made of intestines of inferior quality or which have been stained by commencing putrefaction. The pieces while still moist, are sewed together with strips of the outer membrane or *filandre*, each junction being cut aslant, so as to make it smooth and strong. Three or four of these intestines are then attached by strings to the whirl, and are twisted in the usual way, after which the cord is smoothed and deprived of moisture by the hand of the workman, and is left stretched for a time. It is again twisted, and rubbed with a bunch of horse-hair. The inferior kinds of cords are made by twisting one gut along with two or three pieces of the *filandre*.

Whip-cord is made of intestines of good quality, prepared, cut slanting, and sewed as above described. Each end is then twisted separately, as whip-cord is seldom made of two intestines twisted together. The cord is sulphured once or twice, and may then be dyed black with common ink, or of a rose-color with red ink, which the sulphurous acid turns to a pink color, or with a green dye sold for the purpose by the color dealers. The cord is then dried, smoothed, and coiled up into suitable sizes for sale.

Hatters' Cords for Bowstrings.—These cords are usually from sixteen to twenty-eight feet long, and are made by twisting the longest and largest intestines of sheep, four, six, eight, ten, or twelve being put together, according to their intended size. The preparation of this kind of cord demands more care than that of those which have already been described, and it must be perfectly free from seams and knots. It is twisted with the wheel in the ordinary manner, and must be well stretched and

smoothed after each operation. When half dry, it is exposed at two different times to the fumes of burning sulphur, after which it is well rubbed with a bunch of horse-hair rope dipped in potash lye, and is finally dried in a state of tension, cut off, and coiled.

Clock-makers' Cord.—This kind of cord differs from the others in being extremely thin, and is made of intestines of the smallest size, or of strips made by dividing each gut into two pieces by drawing it down over a kind of lancet mounted upon a leaden or wooden ball, which guides the blade, the two sections of the gut falling into a vessel placed beneath. Clock-makers, however, sometimes employ cords of larger diameter, made of two or more intestines.

Cords for Musical-instrument Strings.—The strings of musical instruments should be of uniform diameter, perfectly smooth, round, and free from shreds or filaments. They should be as little liable as possible to stretch or break, and should preserve their polish and transparency during all changes of weather. Their manufacture requires great experience and dexterity on the part of the workmen. The best violin and harp strings have been made from time immemorial in Italy, and although those of a superior quality are manufactured in France, the preparation of treble strings, which are peculiarly difficult to make, is confined to Naples. The membranes of lean animals are well known to be much more tough than those of animals in high condition, and the superior quality of the strings made at Naples is attributed in a measure to the smallness and leanness of the sheep in its vicinity.

The guts intended for fiddle and harp strings are first scraped with the greatest possible care. Three and a quarter pounds of potash are then dissolved in six pails-

full of water, and five and a half pounds of pearlash are mixed with the same quantity of water, and the solution is clarified by the addition of a little alum. The two solutions are kept in stone-ware vessels. Stone-ware pans are then half filled with the intestines, and the potash liquor, mixed with an equal quantity of water, is poured in until the vessels are full. The intestines are steeped for three or four days or even a longer time, the solution being changed twice daily, and made progressively stronger by adding each time some of the ash-lye, and by diminishing the quantity of water mixed with it. Each time that the solution is changed, the intestines are removed from the vessels, and are replaced after draining upon a sloping table, and after being passed through a thimble in the manner before described. The effect of the alkaline solution upon the intestines is to bleach and swell them, and they must be removed from it upon the first appearance of little bubbles of gas escaping from them, or they will be softened and rendered unfit for use. This is more apt to occur in summer than in winter, and strings of the best quality are made in the latter season.

After being again passed through the thimble so as to smooth and equalize their surfaces, and washed in fresh water, the intestines are attached to the frame in order to be twisted. This frame is five feet three inches in length, and twenty-five inches in breadth. A number of pegs are fixed in one of its sides, and a double number of holes are bored through the other side, so that the cords passed through them are kept in place when pegs are introduced. The ends of the intestines are first placed together upon the edge of the tub in which they have been soaked, and two or three or more of the same diameter and length are selected, and fixed to one of the

double holes by means of a peg, and the bodies of the intestines are then drawn out exactly of the same length, and brought over the corresponding large pegs on the opposite sides of the frame, the ends being carried back and fixed in the other one of the two holes. If some of the intestines are not sufficiently long to stretch across, they are sewed to other pieces as near as possible to the end of the cord, so that the points may be near the extremity of the string, and may not interfere with the uniformity of surface of its main part. The intestines are then twisted on the hooked wheel in the ordinary manner, and are exposed for two or three hours in the sulphuring room, after which they are forcibly rubbed with the horse-hair rope, and twisted and rubbed again. They are again exposed to the vapors of burning sulphur, are twisted once more and sulphured for a third time, after which they are left to dry in a state of tension.

The strings are known to be sufficiently dry, when one of the strands upon being removed from its peg, shows no tendency to turn, but remains in the straight position in which it is held. When the strings have arrived at this degree of dryness, they are rubbed over with olive oil, are cut off at the ends, and coiled up for sale.

The fourth strings of violins, which are wrapped in wire, or other strings wrapped in the same way, are neither sulphured nor oiled. The string intended to be wrapped is cut of the length of a yard and a quarter, and one of its ends is attached to the hook of the wheel, and the other to the ring of a whirl, which keeps the string stretched, by means of a weight at the end of a cord fastened to it and passing over a pulley. The wire is then fastened around the string close to the whirl, and,

as the wheel is made to revolve, the string and the whirl turn with it. The workman supports the string with his left hand; and the wire passing through his right hand is made to revolve around it in close spiral turns until it is entirely and equally covered.

As has been before observed, the utmost care and skill, on the part of the workmen, are required for the manufacture of harp or violin strings of good quality. Too much or too little scraping of the surfaces, the use of too strong lye, the exposure to the vapors of sulphur for too short or too long a time, or defective twisting, will any, or all of them, impair the quality of the product. Long experience alone will enable the workmen to conduct the different operations with the requisite dexterity.

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